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Unsupervised Region Growing Multi objective Genetic Algorithm for Image Segmentation

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Abstract: ***An Real Life image consists of different objects. It is required to identify different objects available in image to understand it properly for some specific purpose. Identification of different parts of a scene is required to automate the process of pattern recognition. There are many algorithms for image segmentation. These methods are not accurate and fail in case of complicated real life images and sometimes in case of blurred images. A multi objective genetic algorithm has been proposed to find accurate segmentation of a real life image. Genetic algorithm along with multi objective criteria produces segregation of images in natural shapes with sufficient accuracy. These objectives include color homogeneity, color gravitational center of segments and differences of one segment with other in their proper context. We have proposed unsupervised region growing multi objective genetic algorithm for image segmentation (URGMOGAFIS) in this paper. The algorithm is efficient to automatically mark image for different segments without human interaction or supervision.***

Different sections in this paper are described in brief here. Introduction part gives description of multi objective genetic algorithm for image segmentation. Methods part describes details of the proposed solution to the problem of image segmentation. Experimental portion gives detail of experiments done on real life data. Results portion of this paper gives comparison of new methods with benchmark methods. Conclusion portion of this paper gives what has been derived and what needs to be done.

I. INTRODUCTION

Image segmentation is also called scene categorization. It is one of the parts of computer vision. At present there are many algorithms for image segmentation and computer vision. These algorithms are not perfect and they do not give good results in comparison to human beings. So there is need of improved algorithms for image segmentation. These algorithms should be in parallel with human beings. That means these algorithms should be very fast like human beings and accurate. To develop these algorithms we should follow procedure followed by our procedure adopted by brain. It is also to be noted that there should be only image as input to algorithms no other human interaction for complete and perfect image segmentation algorithm.

There may be many objects in a scene. We have to develop automated method so that different objects may be identified by fast speed by computer assisted software. This may also be called pattern recognition. Image segmentation is a kind of artificial intelligence like process. Neural networks can be developed to train scene categorization for particular type of circumstances. A neural network cannot predict all and every type of scenes. So we need to develop an algorithm which is robust and efficient for predicting objects available in it for all type of real life images.

An Image consists of pixels. A pixel in color image consists of three color components. These color components are red, green and Blue. In single byte RGB triplets take value of 255 for each R G and B. Real life Images consists of noise i.e. irregular distribution of pixels to distort image. These should be removed from image before applying any Image segmentation technique. For this purpose we should identify neighbors of a pixel as given below in diagram. Each interior pixel consists of eight neighbors in two dimensions. If a pixel is very different from its neighbor then that pixel should be treated as noise and it should be replaced with similar pixel in its neighborhood. This repeated task for the Image will remove all noisy pixels.

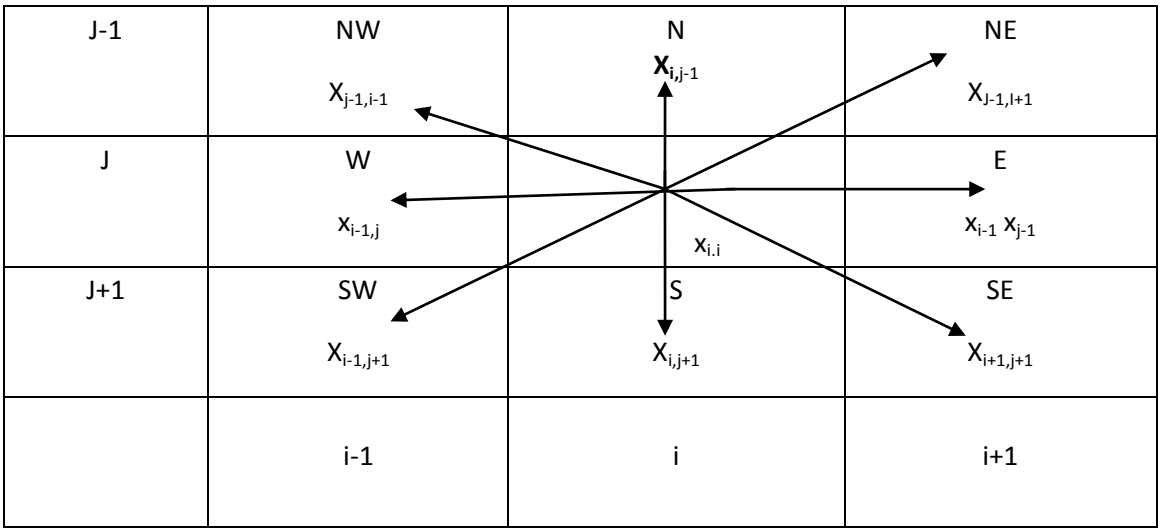

Figure :1 Neighbour's of an Pixel point $X_{i,j}$

When we say an image is to be segmented that means one want to group pixels on some clustering criteria. Image segmentation is thus a type of clustering in which input to algorithm is an Image. After segmentation, each pixel will belong to some segments. Each pixel will belong to only one of the segments. Also, each pixel of image should be part of some segment of image. There are some following clustering methods available in literature.

1. Hierarchical Approaches. Hierarchical based approach is divided into two categories. A) Agglomerative: in this method pixels are combined different clusters based on similarity one pixel with other pixel.

   B). Divisive. In this method image is divided into major divisions and subdivisions. Again

   Each sub division of image is divided on some criteria like color. This process of division of image continues until we cannot divide into meaningful distinct subdivisions.

   Grid Based Approaches: In this method of Image segmentation an Image (maybe it is very huge) is divided into small size packets. Now packets are merged on the basis of similarity with neighboring packets. Thus this method is useful for dividing a large image into meaning full segments.

2. Density based approaches: In this approach an image is checked on density points. That means on the basis of foreground color image is segments on distribution of pixels on background colour. This method is useful for those images which have very rare distribution on monochromatic background. Thus a region having a particular type of density is considered as belonging to a particular region.

3. Model Based Approaches: In this approach of clustering solution of the problem is sought in already existing solutions. For this purpose we maintain solutions of some specific types of problems i.e. set of images. Now if some new image comes then it is compared with already existing prototypes in the Image Database. If there is some matching image in the database then solution is immediately returned. Otherwise solution is generated from scratch.

There is need of scene categorization i.e. image segmentation for purpose of different objects available in scene. Sometimes this is used to identify some suspected or outsider objects in a scene so that proper action could be taken immediately and automatically by machine. Thus this topic is important as man less surveillance of some geographical area.

Any scene can be taken by camera and changed into an BMP image. BMP image has header portion and data portion. Each pixel in colored BMP image consists of three color representatives. These RGB values may be stored as single byte or 2 byte data per pixel. If is single byte is used then each component of RGB will maximum of 255. Thus there will be possible 255*255*255 = 16581375. If each component of RGB is represented by two bytes then possible colors will $(255*255)^3$. To date, no segmentation algorithm has been developed which can automatically generate an "ideal" segmentation in one pass (or in an open loop manner) over a range of scenarios encountered in practicular outdoor applications.

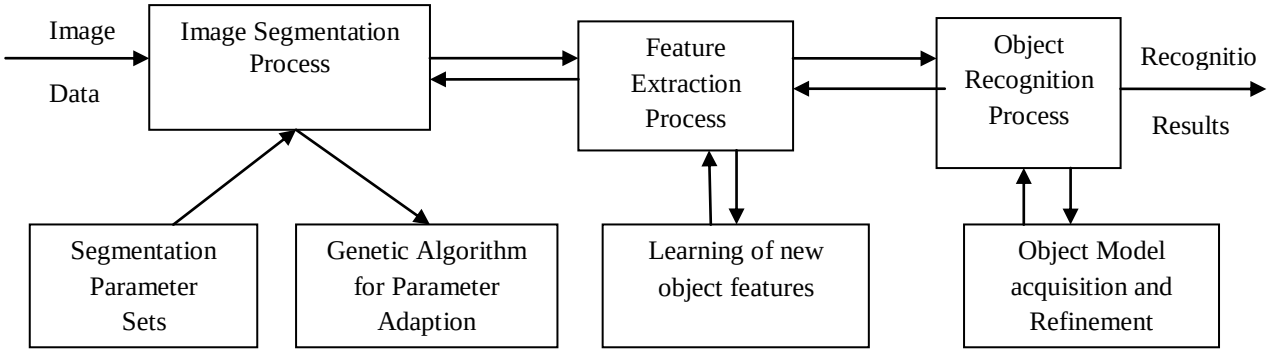

Figure -2 Conceptual design of the multi–level computer vision process

Genetic algorithms are used to solve complicated optimization problems. Genetic algorithms are used to generally solve those problems which are combinatorial optimization in nature. It is an approximation method. In this method an initial population of solutions is generated. Mutation and crossover operators are used to generate new offspring from parent chromosome. Sufficient number of mutation and crossover operators is applied on population so that population of chromosomes converges to fittest set of solutions. In this method it is not always guaranteed that search would end in finding extremum solution. Sometime this Genetic algorithm gives more than one solution with same value of fitness function. These identical value solutions are called degenerate solutions. It is probabilistic in nature and different runs of this algorithm will give slightly different solutions. The search space may be very large and genetic algorithm uses population of good solutions to converge to extremum solutions.

The proposed unsupervised region growing multi objective genetic algorithm for image segmentation consists of two steps. Segment Identification and refinement of resultant segmentation by Multi objective genetic algorithm. Number of segments to be identified is finding out by region growing methods. In second part, Genetic algorithm starts with the two parameters namely Input Image and number of segments. Genetic algorithm is a type of self learning system and it searches all possible solutions to find best solution under given set optimization criterions. The proposed algorithm automatically finds different segments of the given image automatically.

In general, classical Genetic algorithms consist of three operators mutation, crossover and selection. Mutation consists of single bit change of the chromosome. Mutations can occur at one, two or three points of a chromosome. If mutation takes place at two points, it is called two point mutation. If mutation takes place at three points of a chromosome it is called three point mutation. The new offspring may be better than the parents. We select it undeterministically to include in population of chromosomes.

Crossover operator crosses two parent chromosomes and creates two new offsprings. In this crossover operation, two parents are selected at random from population. Both chromosomes are cut at single random point. One portion of first chromosome is merged with other portion of second chromosome and new offspring is checked for validity. Likewise second part of first chromosome is merged with first part of second chromosome and new offspring thus obtained is checked for

chromosome validity. New offspring are evaluated for fitness values. If offspring is better than parents then it is included in population with probability α. Here α have values between 0 and 1. Here it is to be noted that the offsprings may be better than the parents but we do not select them always deterministically so that population may evolve and solution may cross local optimal points.

II. METHODS

Image segmentation can be done in supervised and unsupervised manner. In supervised manner there is input to algorithm that there will be n number of image segments. In unsupervised image segmentation number of image segments are decided on features available in image. There is no input parameter for image segmentation. Unsupervised segmentation is one of important requirements for computer vision system.

First we make list of important characteristics of image. Some of important characteristics of a given image are given below.

1. Number of colors.
2. Total Number of pixels per color.
3. Total Number of distinct regions. Regions which are clearly identifiable by region growing methods of image segmentation.

On large scale image is broadly divided into distinct segments by region growing method of image segmentation. In unsupervised segmentation, we give BMP image as input to the algorithm of region growing. It gives number of regions. This number of regions and Image is input to genetic algorithm for clear segmentation of the Image. The results of segmentation come after a lot of computational calculation in input BMP image.

An image consists of many pixels. Suppose there are n pixels in an image. We can number pixels as x_1, x_2, x_3,…x_n. Now we want to divide these n points in m clusters as segments. We can show this grouping of pixels into cluster by simple two row table.

Pixel Number	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	------	----	------	X_n
Cluster Number	1	2	1	1	2	1	3	2				m

Thus all n x_i pixel points have been assigned to any one of these m clusters. It is to be noted that all m cluster should contain some points. Any one of these cluster group should not be empty. It is also necessary that totals point of these clusters should be equal to all points in image i.e. n. Thus every point of the image will be in any of these m cluster.

For segmentation by genetic algorithm we have to keep in mind that there should be no cluster invalidity during cluster evolution process. That means after operation of genetic algorithm number of cluster should be same as that was before operation of genetic operators on these clusters.

Mathematically we can represent operation of two point crossover as given underneath. Suppose we have two solutions of the problem X and Y. Then, they can now be linearly combined to obtain new two solution X' , Y' as given below.

$$X' = \alpha*X + (1-\beta) *Y.$$

$$Y' = (1-\alpha)*X + \beta*Y.$$

X' and Y' are new off springs obtained from linear combination of chromosomes X and Y. Here in this case $\alpha+\beta=1$.

We used population of chromosomes to simulate learning in Genetic algorithm. Population of chromosomes consists of randomly generated solutions to maintain enough diversity in it. Mutation and Crossover operators are applied for each

generation for fixed number of times. Population of chromosomes evolves like evolution theory of human being. For Crossover and Mutation Operations Parent Chromosomes are randomly selected so that best fit solution does get stuck in local minima or maxima. For this purpose selection of offspring after mutation and crossover is done in probabilistic manner to maintain sufficient diversity in population of chromosomes.

III. ALGORITHM

The proposed algorithm URGMOGAFIS has following steps for accurate image segmentation. We first identify number of regions by region growth method. Then we create allocation of pixels in the clusters. In this method we keep in mind that pixels having similarity with neighboring points are allocated to same cluster at most. We have also used new dissimilarity measurement function to speed up objective function (fitness function) evaluation. It is simply based on color difference between two pixels.

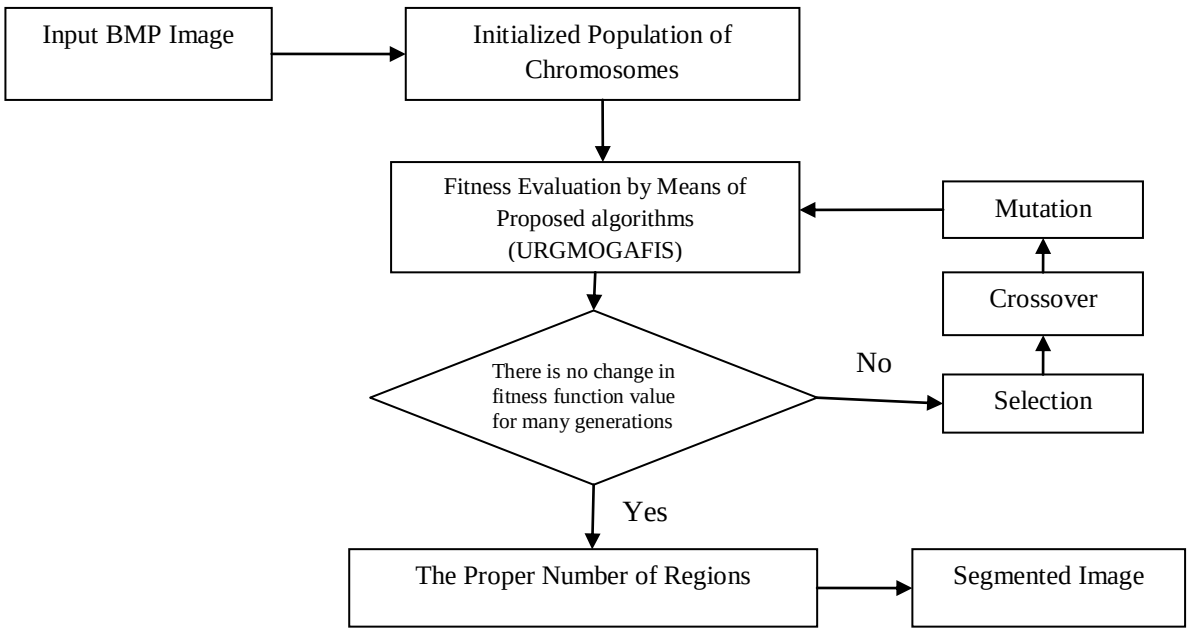

Fig -3 Schematic flow chart of segmentation

1. Take BMP image of the scene.
2. Find characteristics of BMP image, i.e. number of pixels per color, distinct boundaries available in image by region growing methods.
3. Randomly generate population of chromosomes. Population will consist of 10*number of easily identifiable regions.
4. Apply 30 crossover and 10 mutation operator for each generation.
5. Replace parent solution with best offspring obtained after crossover and mutation.
6. Repeat above steps 4 and 5 for reasonable time i.e. half or one hour. Above loop may also be terminated when there is no change in population for 4-5 generations.
7. Find best chromosome from above population.
8. Best chromosome is ultimate solution for our purpose.

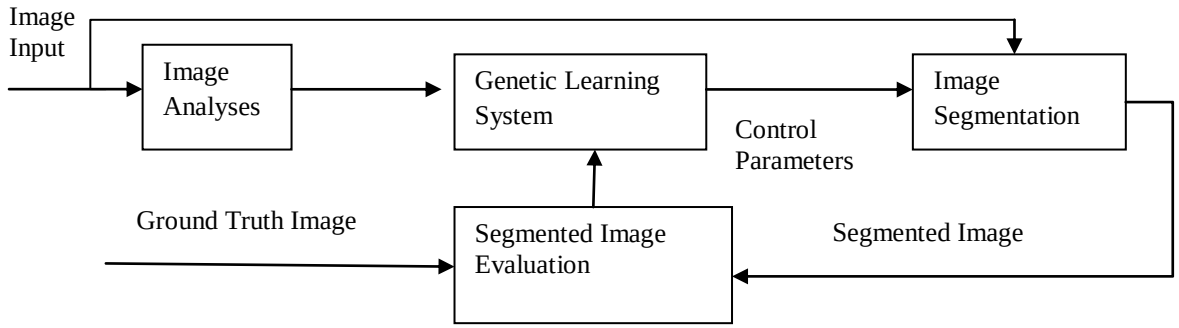

Fig-4 Block Diagram of Adaptive Image Segmentation

IV. EXPERIMENT

Material: for the purpose of Image segmentation we can take any BMP image from mobile cell. Save the Image as BMP file. Download image into Personal Computer and apply on it proposed algorithm for segmentation.

Methods: We took image from real life scenes. It was converted into BMP File. We applied our algorithm on it. Program was executed for many hours and at last we found that our algorithm correctly divided the image into proper segments. It is to be noted that as we run our algorithm for longer duration more accurate results are obtained.

Results: Results of segmentation of the given BMP image is better than results obtained by similar research work done by other researchers. Our results are very satisfactory and encouraging. We have verified our segmentation results with standard image segmentation verification tools. We have checked that total number of pixel points in segmented image is same as it was in original input image to algorithm.

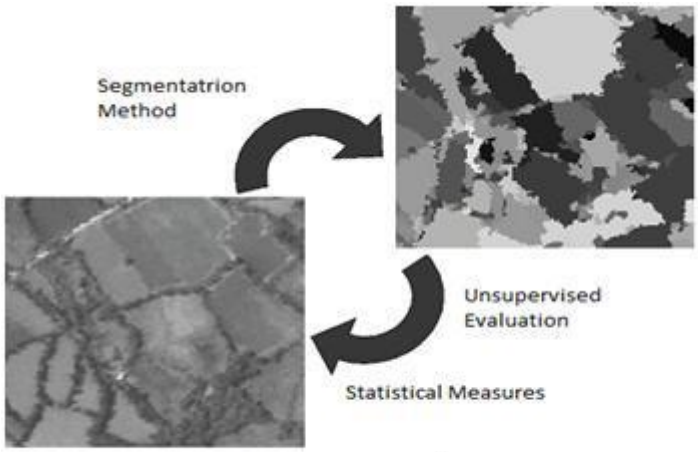

Figure-5 Results of unsupervised Image segmentation by Genetic Algorithm

In figure 6 we have image (a) as input. Initially we generate population of initial solutions by random allocation of pixels to different segments. As time passes segments improves by merging of good quality parents. Mutation operation acts as changes agent and solution does not get stuck in local optimum. It creates enough diversity in solution space.

In the following table we see that there is fast change in difference value of chromosomes. As we are applying crossover and mutation operators, there is little or slow changes after few generations. In the beginning pixel have been randomly allocated to different segment groups, so there is large value for square of pixel differences. But it decrease on selective adoption of better chromosome in evolutionary process of segmentation.

S.No.	Generation Number	Difference of all segments in a chromosome
1	1	105342208
2	15	104038785
3	27	102962361

4	144	98585366
5	865	54205458
6	866	53933263
7	934	53808286
8	1859	31020767
9	3118	21465033
10	4356	19055981
11	6240	16381848
12	11999	16016050

Table -1 Difference of all segments in a chromosome for different generations

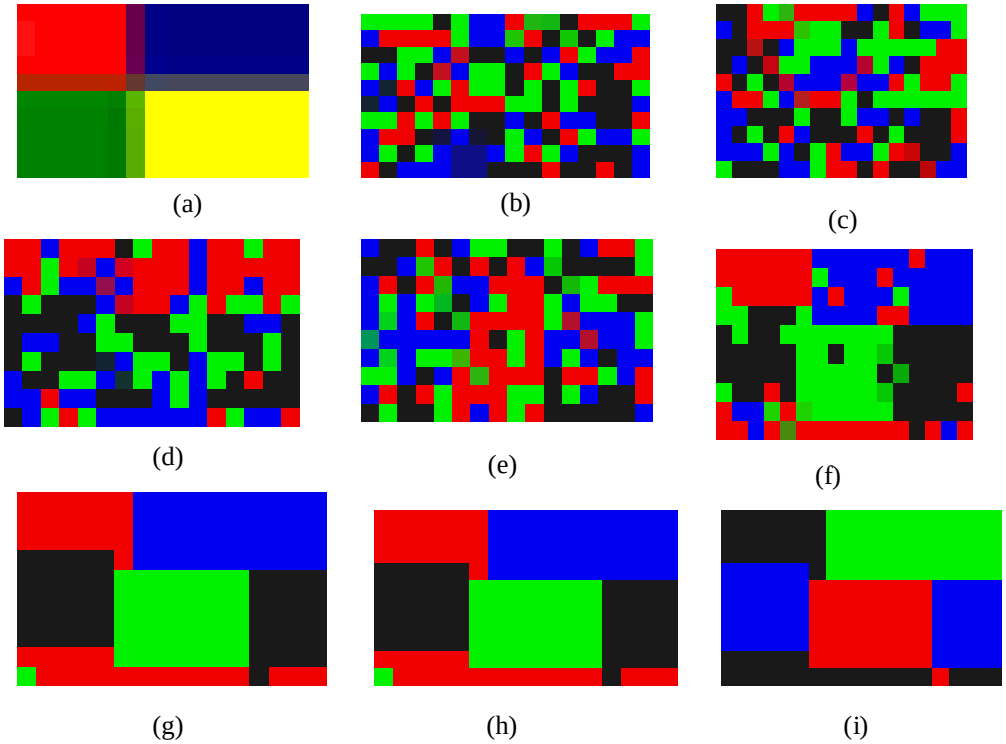

Figure-6 different stages of output by proposed algorithm for input image a.

V. CONCLUSION

This new algorithm URGMOGAFIS gives satisfactory segmentation of input image in comparison to manual categorization of same input image file. It is to be note worthy that image segmentation results need to be improved further on two points. First this algorithm should be modified to reduce time consumed in giving accurate segmentation results for large scenes. Another improvement in this algorithm is concerned with accuracy of segmentation results in comparison to.

Image segmentation can be improved by attacking the problem from multiple points of view. It can be segmented first on the edge detection methods. Then segments can be compared with existing database of shapes. Now segmentation process iteratively can be improved on identification of well known objects of real world and segments of the given image. When we find that certain part of image is a particular object of real world, then we can increase or decrease segment boundary in the given image for fittest image segmentation result. This process is left to reader for further research.

It is to be noted that our eye detects image segments on piece wise basis. First it identifies a small part of an image and then other part of image and so on. Then our mind merges different parts of image into meaning full segments and subsequently into meaning fully object identified image. Same procedure should be followed by computer algorithms also. That means Computer algorithms should identify different parts of image by genetic algorithms and then these parts should be merged by computer into meaning full objects using segments database. So, further research can be carried out on these points.

New fitness function dependent on color of segments and center of segments have been used to increase accuracy of image segmentation. On the basis of similarity of segments, two or more segments can be merged to increase further accuracy of

predicted image segmentation results. Thus iterative refinement strategy combined with related knowledge base will give more improved results.

References

1. E. R. Hruschka, R. J. G. B. Campello, A. A. Freitas, and A. C.P. L. F. de Carvalho, "A survey of evolutionary algorithms for clustering," IEEE Transactions on Systems, Man and Cybernetics Part C: Applications and Reviews, vol. 39, no. 2, pp. 133–155,2009
2. A. Banerjee, "An improved genetic algorithm for robust fuzzy clustering with unknown number of clusters," in *Proceedings of the 29th Annual North American Fuzzy Information Processing Society Conference (NAFIPS '10)*, July 2010.
3. Angel Latha Mary, S., K.R. Shankar Kumar,"A Density Based Dynamic Data Clustering Algorithm based on Incremental Dataset", Journal of Computer Science 8 (5): 656-664, 2012.
4. Vijendra Singh ,Ashwini and Shahu Laxman,"A Fast Evolutionary algorithm for automatic evolution of clusters", Information technology Journal 11(10) 1409-1417 2012.
5. Amine m. Bensaid, Lawrence O Hall, "Partially Supervised Clustering for Image Segmentation ",Pattern Recognition , Vol. 29,No. 5, pp. 859-871,1996.
6. Luis Garcia Ugarriza, Eli Saber , Sreenath Rao Vantaram, Vincent Amuso, Mark Shaw, and Ranjit Bhaskar, "Automatic Image Segmentation by Dynamic Region", IEEE Transactions on Image Processing,Vol.18,No. 10, Oct 2009.
7. Song Chun Zhu and Alan Yuille ,"Region Competition: Unifying Snakes, Region Growing, and Bayes/ MDL for Multiband Image Segmentation", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.18, No. 9 , Sep-1996.
8. Wen-Bing Tao, Jin-Wen Tian,Jian Liu, "Image Segmentation by three-level thresholding based on maximum fuzzy entropy and genetic algorithm",Pattern Recognition Letters 24 (2003) 3069-3078.
9. Andy Tsai, Anthony Yezzi, and Alan S. Willsky, "Curve Evolution Implementation of the Mumford-Shah Functional for Image Segmentatioin, Denoising,Interpolation, and Magnification", IEEE Transaction Image Processing, Vol,10 No.8, August 2001, p.p. 1169.
10. Hichem Talbi, Mohamed Batouche, Amer Draa , " A Quantum-Inspired Evolutionary Algorithm for Multiobjective Image Segmentation", International Journal of Computer, Information Science and Engineering Vol:1 No:7, 2007.
11. S. Chabrier, C. Rosenberger, B. Emile, and H. Laurent, " Optimization-Based Image Segmentation by Genetic Algorithms", EURASIP Journal on Image and Video Processing Volume 2008, Article ID 842029.
12. M. A. Abdallah*, Ashraf Afifi, E. A .Zanaty, Combining Evolutionary Algorithms and Average Overlap Metric Rules for Medical Image Segmentation, *Journal of Global Research in Computer Science*, Volume 4, No. 12, December 2013
13. L. Tang, L. Tian, B. L. Steward ,"Color Image Segmentation with Genetic Algorithm for in-field Weed sensing", American Society of Agricultural and biological engineers ,VOL. 43(4): 1019-1027.
14. Bir Bhanu,Sungkee Lee,Subhodev Das, " Adaptive Image Segmentation Using Genetic and Hybrid Search Methods", IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS VOL. 31, NO. 4 OCTOBER 1995.
15. Bir Bhanu, Sungkee Lee, John Ming , "Adaptive Imag Segmentation Using a Genetic Algorithm", IEEE Transactions On Systems, Man and Cybernetics, Vol,25,No 12 Decmber 1995.
16. Ming-Der Yang, Yeh-Fen Yang, Tung-Ching Su, and Kai-Siang Huang "An Efficient Fitness Function in Genetic Algorithm Classifier for Land Use Recognition on Satellite Images", Scientific World Journal Volume 2014, Article ID 264512.
17. Omid Jamshidi and Abdol Hamid Pilevar, "Automatic Segmentation of Medical Images Using Fuzzy c-Means and the Genetic Algorithm", Journal of Computational Medicine Volume 2013, Article ID 972970.
18. Nikhil R Pal, Sankar K Pal, "Review of Image Segmentation Techniques", Pattern Recognition, 1993,Vol. 26, No 9, pp 1277-1294.

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