ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 3, March 2017

A Survey on Clustering Algorithms for Image Segmentation

Sneha Pise[1], H. R.Turkar[2], A. V. Anjikar[3], A. Golghate[4], P. Khobragade[5]

M.Tech Student, Dept. of CSE, Rajiv Gandhi College of Engineering and Research, Nagpur, Maharashtra, India[1]

Professor, Department of CSE, Rajiv Gandhi College of Engineering and Research, Nagpur, Maharashtra, India[2]

Assistant Professor, Department of IT, Rajiv Gandhi College of Engineering and Research, Nagpur, Maharashtra, India[3]

Assistant Professor, Department of CSE, Rajiv Gandhi College of Engineering and Research, Nagpur, Maharashtra, India[4]

Assistant Professor, Department of CSE, Rajiv Gandhi College of Engineering and Research, Nagpur, Maharashtra, India[5]

ABSTRACT: In digital Image processing many techniques have been proposed for segmentation of different types of images. Image segmentation is an important Image processing step and it is used everywhere if we want to analyze what is inside the image . Image segmentation is the process of partitioning a digital image into multiple segments. Segmentation techniques convert complex image into simple image, so the image become easier to understand. This paper surveys image segmentation techniques and clustering based image segmentation algorithms. From the survey it is clear that clustering techniques are widely used for segmentation of natural images and by using clustering algorithms image segmentation can be done in effective way.

KEYWORDS: Digital Image Processing, Image segmentation, Region based, Thresholding, Edge based, Clustering;

I. INTRODUCTION

Digital image processing refers to processing digital image by means of digital computer. Fundamental steps in digital image processing are image acquisition, image enhancement, image restoration, color image processing, image compression, image segmentation and image recognition.[15] In order to process the image we need to segment it so that it would become easier for the computer to understand.[22]

Digital image processing is the use of computer algorithms to perform image processing on digital images.[25] Interest in digital image processing methods stems from two principal application areas: improvement of pictorial information for human interpretation and processing of image data for storage, transmission, representation for autonomous machine perception. [36]

Image segmentation is the process of subdividing an image into its constituent part and extracting these part of interest which are the objects. The main goal of image segmentation is domain independent partitioning of an image into a set of disjoint regions that are visually different, homogeneous and meaningful with respect to some characteristics or computed properties such as grey level, texture or color to enable easy image analysis (object identification, classification and processing). [6]

Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. The result of image segmentation is a set of segments that collectively cover the entire image or a set of contours extracted from the image.[9]Practical application of image segmentation range from filtering of noisy images, medical applications (Locate tumors and other pathologies, Measure tissue volumes, Computer guided surgery, Diagnosis, Treatment planning), Locate objects in satellite images (roads, forests, etc.), Face Recognition, Finger print Recognition, etc.[19]

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 3, March 2017

Clustering in image segmentation is the process of identifying groups of similar image primitive. In clustering the main process is to represent the image in a clear way.[7] Clustering means classifying and distinguishing things or images that are provided with similar properties, clustering is a classification technique.

Clustering based image segmentation technique involves k-means algorithm, fuzzy c-means algorithm, moving k-means algorithm, fuzzy moving k-means algorithm, adaptive moving k-means algorithm, adaptive fuzzy moving k-means algorithm, Enhanced moving k-means algorithm for assigning pixels to given number of clusters.

Before a clustering method can be applied to image data in order to extract some specific piece of information, it is usually necessary to process the data in order to assure that it satisfies certain assumptions implied by the method. Matlab is an interpreted language for numerical computation, it allows us to perform numerical calculations and visualize the results without the need for complicated and time consuming programming, matlab allow users to accurately solve problems, produce graphics easily and produce code efficiently.[6]

II. RELATED WORK

M. Lalitha[9] presents, Clustering concepts and image segmentation concepts and survey on different clustering techniques to achieve image segmentation. R.Dass, [4] classify and discuss main image segmentation techniques, investigates and compiles some of the technologies used for image segmentation. A. Bali [29] discusses about many aspects of image segmentation, the basic principle of segmentation techniques, how it can be implemented and what are the applications of these techniques are, the different techniques are broadly categorized as humanly implemented or machine implemented. G.S. Chandel[6] presents the analysis and implementation using MATLAB features and one best result can be selected for any algorithm using the subjective evaluation. P.Sravani[8] gives overview of different segmentation methods and clustering. Many techniques are developed for image segmentation, not all types are useful for all types of images. Yanni Zou [32] surveys the image segmentation techniques based on the clustering. It also gives idea about the combination of FCM clustering algorithm with genetic algorithm to achieve global optimization. FCM involves a lot of subjects, fuzzy mathematics is the theory basis of it, the construction of the model is quite flexible.

Ms.Chinki Chandhok[5] presents a new approach for image segmentation by applying k-means algorithm, implemented k-means clustering algorithm. For smaller values of k the algorithms give good results, for larger values of k, the segmentation is very coarse , many clusters appear in the images at discrete places . Prachi Surlakar[31] present brief comparison between K-Means and K-Nearest Neighbor segmentation algorithms in the field of medicine. These algorithms have been evaluated on tumor affected cells. B.Sai Chandana[18] has presented four clustering algorithms namely K-means, Moving K-means, Fuzzy Kmeans and Fuzzy Moving K-means combined with hill climbing for the classification of remote sensing image. The qualitative and quantitative analysis done proved that Fuzzy Moving K-means has higher classification quality than other clustering algorithms.

Verma S. V. [33] implemented MKM and AFKM algorithm in a very effective way, it works effectively when pixels are not properly separated from each other. AFKM also reduces cluster to cluster variance, but it does not make sure that the final result has a global minimum of variance. F.U.Siddiqui [3] introduce Enhanced Moving K-Means algorithms i.e. EMKM-1 and EMKM-2 as the modified versions of the conventional Moving K-Means(MKM) algorithm. Ms.Aparna K [26] describes from the experiments on the high dimensional data sets, find that K-Means with Ant Colony Optimization algorithm performs well and provides meaningful and useful results in terms of clustering quality which contain interdependence information within clusters.

III. IMAGE SEGMENTATION TECHNIQUES

Image segmentation techniques can be categorized as:

A. Region Based Method
B. Thresholding Method
C. Edge Based Method
D. Clustering Method

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 3, March 2017

A. Region-based Method

In region-based method it is assume that the neighboring pixels within one region have similar value, it compares one pixel with its neighbors, if a similarity criterion is satisfied the pixel can be set belong to the cluster as one or more of its neighbors.[6] Region-based segmentation methods are based on the fact that a pixel cannot be considered a part of an object or not based solely on its gray value (as intensity-based methods do). They incorporate measures of connectivity among pixels in order to decide whether these pixels belong to the same region (or object) or not. [17] Initial selection of seed point affect the final result, this method can be sensitive to noise and also sensitive if seed lies on edges. [8]

B. Thresholding Method

Thresholding method is a simple but powerful approach for segmenting images having light objects on dark background, thresholding operation convert a multilevel image into a binary image i.e., it choose a proper threshold T, to divide image pixels into several regions and separate objects from background. [17] Thresholding method can be expressed as: T=T[x, y, p(x, y), f(x, y] , Where: T is the threshold value. x, y are the coordinates of the threshold value point. p(x,y) ,f(x,y) are points the gray level image pixels. [21] Thresholding becomes then a simple but effective tool to separate objects from its background. [6] As the grayscale contrast between target image and background is relatively strong, the threshold selection is relatively easy, due to poor lighting or too much image noise, the contrast between the target and background is often not obvious enough, at this time, the threshold selection is not easy. [30]

C. Edge Based Method

In edge based method the boundary is identified to segment, edges are detected to identify the discontinuities in the image. In edge based segmentation there is no need for the detected edges to be closed. [24] This method resolve image segmentation by detecting the edges or pixels between different region that have rapid transition in intensity are extracted, linked to form closed object boundaries. [12].Edge detection is the process of identifying and locating sharp discontinuities in an image. Edge based method is one of the most frequently used techniques in digital image processing. The boundaries of an object surfaces in a scenes lead to oriented localized changes in intensity of an image called edges. [17] Edge detection techniques convert an image to edge image and have the benefit from change of grey tones in the images.[21]

D. Clustering Method

Clustering is unsupervised learning method. In clustering method a collection of 'pixels' are examined and grouped into 'clusters'. Similarities between the points are measured, similarity can be distance measure. Pixels are grouped with their closeness.[8] The quality of the segmentation depends upon the digital images, in the case of simple images the segmentation process is clear and effective due to small pixels variations, whereas in the case of complex images the utility for subsequent processing becomes questionable.[12] A good cluster should be compact and separable which means minimum intercluster distance and maximum intracluster distance, inter cluster distance is the distance between the objects and centroid within the cluster, intra cluster distance is the distance between the cluster centroids.[20] Image segmentation using clustering is widely used due to the simplicity of understanding and more accurate results.[10]

Clustering is mainly used when classes are known in advance. A similarity criteria is defined between pixels and then similar pixels are grouped together to form clusters. The quality of a clustering result depends on both the similarity measures used by the method and its implementation. A good clustering method will produce high quality clusters with high intraclass similarity – similar to one another within the same cluster, low interclass similarity.[12]. The partition based methods use optimization methods iteratively to minimizes an objective function.

There are basic two types of clustering.

1. Hard clustering

Hard clustering methods are applicable to data sets that have a large difference between groups i.e. it has sharp boundaries between clusters and a pixel belongs to one and only one cluster. It is simple to implement and computational cost is low, which makes it the first preference with large data sets. In hard clustering K i.e the number of clusters must be determined, it may lead to different results for each execution which depends on initial cluster centroids. [14]

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 3, March 2017

2. Soft Clustering

In real time applications, one of the most difficult task in image analysis & computer vision is to classify the pixel in an image correctly , when there is no crisp boundaries between objects in an image thus in order to address this difficulty fuzzy clustering techniques are used.[8] The soft clustering is more natural type of clustering because in real life exact division is not possible due to the presence of noise, so the soft clustering techniques are useful for image segmentation in which division is not strict. In this technique pixels are partitioned into clusters based on partial membership i.e. one pixel can belong to more than one cluster and this degree of belonging is described by membership values.[25]

There are various algorithms in hard clustering and soft clustering to find clusters.

i. K-Means (KM)Algorithm:

The main idea behind the k-means clustering algorithm is to group the pixels into clusters. [13] K-Means is a well known partitioning method.[35] K-Means clustering generates a specific number of disjoint, non-hierarchical clusters. Each pixel is assigned to the cluster based on the closeness, which is determined by the Euclidian distance measure. [9] K-means also produces relatively high quality clusters considering the low level of computation required .[23] K-means is generally used to determine the natural grouping of pixels present in an image. [10]

K-means algorithm properties:

- There are always K clusters.
- There is always at least one item in each cluster.
- The clusters are non-hierarchical and they do not overlap .
- Every member of a cluster is closer to its cluster than any other cluster because closeness does not always involve the center of the clusters.

K-means algorithm have following advantages:

1) Fast, robust and easier to understand.
2) Relatively efficient.
3) Gives best result when data set are distinct or well separated from each other.
4) K-Means produce tighter clusters than hierarchical clustering.
5) Works well with large datasets.

K-means algorithm have some disadvantages:

1) The number of clusters K must be determined before the algorithm is executed and it is time consuming process.
2) The algorithm is sensitive to initial condition.
3) Poor pixel assignment could occur if the pixel with the same minimum Euclidean distance to two or more adjacent cluster and it may be assigned to the higher variance cluster leading to dead center problems.

ii. Fuzzy C-means (FCM) Algorithm:

In fuzzy C-means each pixel has simultaneously belongs to a degree of clusters rather than completely belongs to one cluster called membership and distributes membership values in normalized fashion.[13] Fuzzy C-Mean (FCM) is an unsupervised clustering algorithm that has been applied to wide range of problems involving feature analysis, clustering , classifier design. [23] It distributes the membership values in a normalized fashion, it does not require prior knowledge about the data to be classified. [18] FCM employs fuzzy partitioning such that a given data point can belong to several groups with degree of belongingness specified by the membership grades between 0 and 1.

Advantages:

1) Gives best result for overlapped data set and comparatively better then k-means algorithm.
2) Data point is assigned membership to each cluster center as a result of which data point may belong to more than one cluster center.

Disadvantages:

1. It is very sensitive to outliers and could not create similar segments of the image.
2.It converges to local optimum value.
3. It is not suitable for the corrupt images, having noise and salt/pepper effect.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 3, March 2017

iii. Moving K-Means (MKM) Algorithm:

The Moving K-means clustering algorithm is the modified version of K-means algorithm. It introduces the concept of fitness to ensure that each cluster should have a significant number of members and final fitness values before the new position of cluster is calculated. [13] The MKM algorithm is based on non-adaptive clustering technique. The algorithm is called moving k-means clustering because during the clustering process, the fitness of each centre is constantly checked and if the centre fails to satisfy a specified criterion the centre will be moved to the region that has the most active centre.[37]

The algorithm is designed to have the following properties:

• All the centres will have about the same fitness in term of the fitness criteria, so there is no dead centre.

• More centres will be allocated at the heavily populated data area but some of the centres will also be assigned to the rest of the data so,that all data are within an acceptable distance from the centres.

• The algorithm can reduce the sensitivity to the initial centres hence, the algorithm is capable of avoiding poor local minima.[37]

Advantages:

1)To overcome the problems of fcm the fitness concept is used.

2) It is much competent to overcome the problems of fcm and also reduces dead centers and center redundancy problems.

3)The effect of trapped center at local minima is also reduced.

Dis advantages:

1)It also much sensitive to noise.

2) In certain images the clusters or centers are unable to locate, which tends to inaccurate outputs.

3)At the time of updating process, all the clusters must be active, otherwise the cluster having highest value of fitness has to share his members with lowest value of fitness.

iv. Fuzzy Moving K-means (FMKM)Algorithm :

In the fuzzy moving k-means (FMKM) clustering algorithm, the concept of fuzzy logic is introduced. The main idea of this algorithm is to possibly allow each data member to be assigned simultaneously to more than one class by different degree of membership. This process can be achieved based upon the membership function. For this algorithm, after specifying the membership for each data and applying the fitness calculation process the original relationship among the centers (i.e. as in the MKM algorithm) is modified.[2]

Advantages:

1)The algorithm minimizes the sensitivity to the noisy data by updating the moving member function.

2)It is not obligatory for the members of the center with the largest fitness value to follow the center with the smallest fitness value.

v. Adaptive Moving K-means (AMKM) Algorithm :

One of the weakness of the MKM algorithm is that it obligates the members of the center with the largest fitness value to become a member of the center with the smallest fitness value , even though, the center with the smallest fitness represents a group of noise data. This issue could lead to miss-clustering of data to unwanted noise cluster, which in turn, affects the segmented results.[2]The adaptive moving k-means (AMKM) clustering algorithm provides a solution to this problem by assigning the members of the center with the largest fitness value if to the nearest cluster depending on the minimum Euclidean distance. The process of reassigning the members is different from the conventional MKM as the members of the center with the largest fitness value are conventionally assigned to the center with smallest fitness value. Then, the positions of all the existing clusters are recalculated . The reassigning members procedure will significantly avoid the enforcement of data to inappropriate centers or clusters.

Advantage:

1)It comparatively reduces the cluster variance in some cases.

Dis advantage:

1)It is less effective in avoiding trapped center at local minima and a poor segmentation is often encountered.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 3, March 2017

vi. Adaptive Fuzzy Moving K-means (AFMKM) Algorithm :

The clustering algorithm called the adaptive fuzzy moving k-means (AFMKM) algorithm combines the concepts introduced in the previous two clustering algorithms (i.e. the FMKM and AMKM algorithms).[2] The AFMKM algorithm combines the properties of both algorithms. After assigning each data to the nearest center based on the fuzzy membership function and the fitness function all the members will be assigned to the proper center (i.e. as in the AMKM algorithm).

Advantage:

1)The AFMKM algorithm combines the properties of both fmkm and amkm algorithms.

Disadvantage:

1)These algorithms failing to significantly update the lowest fitness cluster during the iteration and sensitive to initial parameters**.**

vii. Enhanced moving K−means (EMKM) Algorithm:

To overcome the problems of above algorithm, enhanced moving K−means (EMKM) algorithm is used. In this EMKM algorithm, highest fitness cluster which is within the range will be assigned to the nearest neighboring cluster and lowest fitness cluster obtains the members of the nearest neighboring cluster which lie outside of the range.

This process will increase the variance of lowest fitness cluster , which may lead to poor clustering. Thus, in order to keep the variance of lowest fitness cluster(i.e c_l) in reasonable value and avoid highest fitness cluster(i.e c_s) to be trapped at a local optimum location, there are two versions of transferring process for clustered members called EMKM-1 and second version called EMKM-2. [3]

Advantages:

1)EMKM overcomes the MKM weakness without limiting their pre-existing capability (i.e. avoiding trapped center at local optimum location).

2)The EMKM algorithm is less sensitive to the initial parameters.

IV. CONCLUSION

This paper presents different image segmentation technique, this paper also presents algorithms for clustering based image segmentation. Segmentation can be applied to any type of images, many techniques are developed, not all types are useful for all types of images. Thus there is no single method which can be considered good for all type of images, nor all methods equally good for a particular type of image. EMKM algorithm gives better result with less time compare with other algorithms. Determination of the number of cluster before running the algorithm is challenging issue so, an image segmentation remains a challenging problem in image processing and computer vision.

REFERENCES

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, 2nd ed.
2. Nor Ashidi Mat Isa, Samy A. Salamah,” Adaptive Fuzzy Moving K-means Clustering Algorithm for Image Segmentation”, IEEE 2146 Transactions on Consumer Electronics, Vol. 55, No. 4, NOVEMBER 2009.
3. Fasahat Ullah Siddiqui , Nor Ashidi Mat Isa,” Enhanced Moving K-Means (EMKM) Algorithm for Image Segmentation”, 0098 3063/11, 2011 IEEE.
4. Rajeshwar Dass, Priyanka, Swapna Devi, “Image Segmentation Techniques”, IJECT Vol. 3, Issue 1, Jan. - March 2012.
5. Ms.Chinki Chandhok, Mrs.Soni Chaturvedi, Dr.A.A Khurshid,” An Approach to Image Segmentation using K-means Clustering Algorithm”, International Journal of Information Technology (IJIT), Volume – 1, Issue – 1, August 2012.
6. Gajendra Singh Chandel, Ravindra Kumar, Deepika Khare, Sumita Verma,” Analysis of Image Segmentation Algorithms Using MATLAB”, International Journal of Engineering Innovation & Research , ISSN 2277 – 5668,Volume 1, Issue 1,2012.
7. Santanu Bhowmik, Viki Datta,” A Survey on Clustering Based Image Segmentation” , International Journal of Advanced Research in Computer Engineering & Technology,Volume 1, Issue 5, July 2012.
8. P. Sravani , S. Deepa ,” A Survey on Image Segmentation Techniques and Clustering”, International Journal of Advance Research in Computer Science and Management Studies, ISSN: 2321-7782, Special Issue, December 2013.
9. M. Lalitha, M. Kiruthiga, C. Loganathan,” A Survey on Image Segmentation through Clustering Algorithm”, International Journal of Science and Research (IJSR), India Online ISSN: 2319-7064, Volume 2 Issue 2, February 2013.
10. Shiv Ram Dubey, Pushkar Dixit, Nishant Singh, Jay Prakash Gupta,” Infected Fruit Part Detection using K-Means Clustering Segmentation Technique”, International Journal of Artificial Intelligence and Interactive Multimedia, Vol. 2, No 2.2013 .

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 3, March 2017

11. A. M. Khan, Ravi. S," Image Segmentation Methods: A Comparative Study", International Journal of Soft Computing and Engineering (IJSCE), Volume-3, Issue-4, September 2013.
12. H.P. Narkhede, "Review of Image Segmentation Techniques", International Journal of Science and Modern Engineering (IJISME), ISSN: 2319-6386, Volume-1, Issue-8, July 2013.
13. Lakshmana Phaneendra Maguluri, Keshav Rajapanthula, P. Naga Srinivasu," A Comparative Analysis of Clustering based Segmentation Algorithms in Microarray Images", International Journal of Emerging Science and Engineering (IJESE) ,ISSN: 2319–6378, Volume-1, Issue-5, March 2013.
14. Shah Nilima, Patel Dhanesh, Jivani Anjali, "Review on Image Segmentation, Clustering and Boundary Encoding",International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 11, November 2013.
15. Varshali Jaiswal, Aruna Tiwari," A Survey of Image Segmentation based on Artificial Intelligence and Evolutionary Approach", IOSR Journal of Computer Engineering (IOSR-JCE), ISSN: 2278-8727,Volume 15, Issue 3,Nov-Dec 2013.
16. Juilee Anil Katkar, Trupti Baraskar," A Review: Clustering Techniques for Medical Image Segmentation", International Journal of Advance Foundation and Research in Computer (IJAFRC), ISSN 2348 – 4853,Volume 1, Issue 12, December 2014.
17. K. K. Rahini, S. S. Sudha," Review of Image Segmentation Techniques: A Survey", International Journal of Advanced Research in Computer Science and Software Engineering ISSN: 2277 128X Volume 4, Issue 7, July 2014 .
18. Sai Chandana, K. Srinivas, R. Kiran Kumar,"Clustering Algorithm Combined with Hill Climbing for Classification of Remote Sensing Image", International Journal of Electrical and Computer Engineering (IJECE) ,ISSN: 2088-8708,Vol. 4, No. 6, December 2014 .
19. .M. Jogendra Kumar, Dr. GVS Raj Kumar, R. Vijay Kumar Reddy," REVIEW ON IMAGE SEGMENTATION TECHNIQUES", International Journal of Scientific Research Engineering & Technology (IJSRET) ISSN 2278 – 0882 Volume 3, Issue 6, September 2014.
20. A. Pugazhenthi, Jyoti Singhai," Automatic Centroids Selection in K-means Clustering Based Image Segmentation", International Conference on Communication and Signal Processing,IEEE 2014.
21. Rozy Kumari, Narinder Sharma," A Study on the Different Image Segmentation Technique", International Journal of Engineering and Innovative Technology (IJEIT) Volume 4, Issue 1, July 2014.
22. Sujata Saini and Komal Arora," A Study Analysis on the Different Image Segmentation Techniques" International Journal of Information & Computation Technology. ISSN 0974-2239 Volume 4, Number 14,2014.
23. Devarshi Naik , Pinal Shah," A Review on Image Segmentation Clustering Algorithms", International Journal of Computer Science and Information Technologies,ISSN: 3289 – 3293, Vol. 5 (3) , 2014.
24. Ms.R.Saranya P on Selvi, Ms. C. Lokanayaki, "A Survey Paper on Fuzzy Image Segmentation Techniques", Int. Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 4, Issue 3,(Version 1), March 2014.
25. Dilpreet Kaur, Yadwinder Kaur," Various Image Segmentation Techniques: A Review", International Journal of Computer Science and Mobile Computing, Vol.3 Issue.5, May- 2014.
26. Ms. Aparna K and Dr. Mydhili K Nair, "Enhancement of K-Means algorithm using ACO as an Optimization Technique on High Dimensional Data", International Conference on electronics and communication systems, 978-1-4799-2321-2, IEEE 2014.
27. Dibya Jyoti Bora, Dr. Anil Kumar Gupta," Effect of Different Distance Measures on the Performance of K-Means Algorithm: An Experimental Study in Matlab", International Journal of Computer Science and Information Technologies, ISSN 0975 – 9646,Vol. 5 (2) , 2014,.
28. Jadhav Swapnil N. , Prof. Sarita V. Verma," PERCEPTIBLE PERFORMANCE OF DIFFERENT CLUSTERING TECHNIQUES FOR IMAGE SEGMENTATION", International Journal of Scientific Research Engineering & Technology (IJSRET), ISSN 2278 – 0882, Volume 3, Issue 5, August 2014.
29. Akanksha Bali, Dr. Shailendra Narayan Singh," A Review on the Strategies and Techniques of image Segmentation", Fifth International Conference on Advanced Computing & Communication Technologies, IEEE 2015.
30. Li Haitao and Li Shengpu," An Algorithm and Implementation for Image Segmentation', International Journal of Signal Processing, Image Processing and Pattern Recognition, ISSN: 2005-4254 ,Vol.9, No.3 ,2016 .
31. Prachi Surlakar, Sufola Araujo, Dr.K.Meenakshi Sundaram," Comparative Analysis of K-Means and K-Nearest Neighbor Image Segmentation Techniques",IEEE 6th International Conference on Advanced Computing,2016.
32. Yanni Zou, Bo Liu," Survey on Clustering-Based Image Segmentation Techniques", IEEE 20th International Conference on computer supported cooperative work in design,2016.
33. Verma S.V., Jadhav S. N. & M.S.Wadatkar.," Perceptible Study of Some K-Means Clustering Algorithm Used for Image and Data Analysis", IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), ISSN: 2278-8735.
34. Siti Noraini Sulaiman, Noreliani Awang Non, Iza Sazanita Isa, Norhazimi Hamzah," Segmentation of Brain MRI Image Based on Clustering Algorithm", Recent Advances in Electrical and Computer Engineering, ISBN: 978-1-61804-228-6.
35. A. Meena, K. Raja, "SEGMENTATION OF ALZHEIMER'S DISEASE IN PET SCAN DATASETS USING MATLAB".
36. Ravindra S. Hegadi, "Image Processing: Research Opportunities and Challenges".
37. M. Y. MASHOR," Hybrid Training Algorithm for RBF Network".
38. F.U. Siddiqui , N. A. Mat Isa, "Optimized K-means (OKM) clustering algorithm for image segmentation", OPTO−ELECTRONICS REVIEW 20 (3), 216–225.
39. A. V. Anjikar, V. K. Shandilya, "Effective method of Initial Seed Selection Used for Color Image Segmentation", Int. J. Comp. Tech. Appl, ISSN:2229-6093, Vol 2 (3), 431-432.
40. Joel George R, Anitha Jeba Kumari D," Segmentation and Analysis of Lung Cancer Images Using Optimization Technique", International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 10.