

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 9, September 2017

# Segmentation of Colored Images based on Modified Region Merging on RAG-RKM together with SLIC

Rohan Raju Taksande, Sanjay Kumar Kinge, Dr. B. Sheela Rani, Dr. Mukul S. Sutaone

Department of Electronics and Telecommunication, MAEER's MIT College of Engineering, Pune,  
Maharashtra, India

Department of Electronics and Telecommunication, MAEER's MIT College of Engineering, Pune,  
Maharashtra, India

Director Research, Satyabhama University, Chennai, Tamil Nadu, India.

Department of Electronics and Telecommunication, College of Engineering, Pune, Maharashtra, India

**ABSTRACT:** Image Segmentation is an imperative part of computer perception and it stills a difficult and thriving subject for machine and computer perception. Research in computer vision proves that the segmenting of an image into various understandable regions for subsequent post processing (e.g., scene understanding, pattern recognition) is an ambitious task.

In this paper, the proposed system uses various segmentation methods to increase the accuracy of segmentation and satisfactory visual entirety. The segmentation method is based on watershed, modified RAG-RKM and SLIC method. Using the Watershed segmentation we find how many pixels are allotted to which regions. Using modified RAG-RKM method we find the mask and seed pixels using which the contour is plotted with the help of pixel value and angle of direction. The SLIC algorithm is used to find the segmentation of image using the angle of movement which takes into consideration the neighbourhood distance, edges of the regions and the area of the region. The proposed algorithm is applied on BSD300 database which contains 300 natural images. The accuracy of the proposed system is very high. Also the algorithm was applied on random color-texture images and the result found was good.

**KEYWORDS:** image segmentation, computer perception, scene understanding, pattern recognition, watershed, Region Adjacency Graph(RAG), Region level k-means(RKM) , Simple Linear Iterative Clustering(SLIC) etc.

### I. INTRODUCTION

Image Segmentation is fundamental and at the same time very thought provoking subject in computer vision and perception. Segmentation refers to the division of an image into the various disjoint region in order to have meaningful and defined regions. The color segmentation is a very crucial step in image processing and application like object detection, image editing, medical image processing pattern recognition. Still, segmentation of natural images is still very challenging because natural images have no uniformity in color, texture, effects of shadow and they are highly complex. Over the course of time, researchers have studied and developed numerous approaches for image segmentation so that negligible input is given by the user side for segmentation. Science and technology have been developing constantly over the course of years have given very fruitful result where segmentation performance is greatly improved. But the accuracy and reliability is still a topic of concern for the researchers. Fast development in the field of image technology has given rise to different types of digital images. Every site in the multivariate image

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 9, September 2017

depicts distinct aspects of the same scene. The number of vector elements also called feature space dimension in the image provides high levels of information contained in the image. Every pixel has an RGB value and its own coordinates due to which high information is retained. The cluster of pixels belongs to a region(class) and such collection regions gives rise to object or objects in the image along with the background. Segmenting such images into distinct region or regions and background is a challenging task. Intra-class variation is present in the semantically meaningful regions. These regions are not often homogeneous. This inhomogeneity is caused by image environment, noise or the characteristics of the scene. Large intra-class variation reduces the segmentation performance. Also, the cost of computation increases with the robustness of algorithm which often tries to increase the feature space sparseness and solution space complexity. A region-level MRF based algorithm is proposed called as multivariate Iterative Region Growing Using Semantics which deals with color images. This algorithm is sensitive to initial conditions and thus a region-level k-means(RKM) is used to provide robust initialization at low cost.[1]

## II. RELATED WORK

Huisi Wu et al. [2] proposed a new framework for segmentation of cartoon images using an improvised SLIC(simple linear iterative clustering) algorithm to generate more superpixels. The proposed algorithm produces superpixels with regular size and the best part of the algorithm is, it also clings well to the boundaries of the image. The problem arises when the superpixels have a color that is similar to the background and are on the image boundaries. The pivotal point of this algorithm is the inner connectivity between all the generated superpixels. To tackle the inner connectivity issue of color, we grow the region in such a way that the original super-pixels are divided into two or more new superpixels. These superpixels are merged together with adjacent superpixels to obtain a meaningful object. The author proposes Adaptive Region propagation Merging which has a sophisticated parameter setting for the merging threshold which takes into consideration both the spatial and color domain. The merging algorithm takes into account the adaptive center selection to determine which pixels to select first for merging. Also, it determines how the merging regions need to be selected first. The experiments showed that the cartoon image segmentation is as good as the human visual perception. Also, the algorithm is not limited to just cartoon image but also can be used for texture substitution, local brightness adjustment, target detection, etc.

Ranran Dong et al. [3] propose a novel approach for image segmentation. The interactive image segmentation is a region- based approach in which the initial segmentation is done by Super Linear Iterative Clustering (SLIC) superpixels, which gives relevant regions which are represented based on color features and texture features. These regions are merged based on their region similarities. The region similarities are determined based on the Normalized Cross-correlation which used as guidance for region merging process. This region merging takes assistance from user markers. The author proposes SLIC algorithm which uses 5 dimensions [LABXY] for color similarities and distance proximity by initializing the super-pixel cluster centers. The pixels surrounding the above mentioned superpixels forms clusters of pixels until they converge iteratively till few pixels that have the same label in large segment are not connective to each other. The region similarities are by Normalized Cross Correlation using LBP(Local Binary Pattern) histogram and indexed color histogram. The region merging is done until the labelled and adjacent unlabeled region are merged with most similar neighbouring region. This is done iteratively until all regions are labelled as foreground or background. Experiments were done on Berkeley dataset and result found was accurate and reliable.

Rostom Kachouri et al. [4] proposed a new unsupervised image segmentation method called Unsupervised Image Segmentation (UIS) which segments image into primitive regions which is done by local adaptive k-means. Together with centroid initialization, this method collects homogeneous regions. Hierarchical linkage is used for feature merging in the above mentioned region. It tackles the issue of over-segmentation by removing outlier region by post processing stage. The author proposes to form clustering of local image blocks using k-means algorithm. It forms small data blocks and each data block has one single semantic meaningful subject. Local k-means sets two set of centroid. Author selected 9 pixels out of which one pixels belongs to second region if there is one. We initialize two farthest pixels after which each blocks block is clustered with k-means until convergence. For merging we have similarity criteria to determine which regions are similar. We have taken a combination a combination of color and texture features to obtain a sharp boundaries and homogeneous regions. There is a possibility that the merged image may contain outlier region. We eliminate this region by merging them with appropriate regions. The experiments

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 9, September 2017

were conducted on both Corel and Berkeley datasets. Performance evaluation was done according to visual accuracy comparison and Liu's factor measuring.

Tingting Lan et al. [5] proposes a novel object contour extraction method based on salient region detection and an automatic region growing method. Here the original image is partitioned into superpixels using Hexagonally Arranged Iterative clustering (HAIC). The salient objects in the image were located by super-pixel global contrast (SGC) so that the centroid and color set of the background could be determined. Contour Plot was obtained by doing post processing which included open operation and isolated region elimination. HAIC generates superpixels centers and we take centroid of these superpixels as seed and search for similarities in the neighbouring pixels. After which we calculate each superpixels contrast. The author mentions the separating of the object from the background is a challenging task. To tackle this issue, an automatic region growing combined with scanning line to select the seed is used. Region merging of background will give greater regions of segmentation which will separate our target object. Post processing method like morphological process can remove smaller structure and eliminate isolated areas. The experiment was conducted on natural images with simple background and natural images with complex background which comes from MSRA10K dataset and results found were good.

Mohamed Ben Gharsallah et al. [6] propose a new segmentation method for detection of defects in the surface that contains small shapes present in the image. These images have low levels of contrast and are easily affected by uneven illumination. The method is based on level set active contour in which primarily we use Off-center saliency map whose goal is to select the interesting parts of sensory input data due to which the data is to be processed is reduced. In this method, the dark regions are surrounded by bright regions are identified first because that is the nature of the images (defects have low-level contrast). Secondly, the Off-center saliency map obtained is used in the segmentation process because it provides statistical information for level set active contour energy formulation. Experiments were performed on the different industrial images contained different types of deformities. These defects could be used for finding slag inclusion, unfinished penetrations, porosities, gas cavities, etc. The future work for this project is to be used for analysis medical images.

Mona A. S. Ali et al. [7] proposes an approach for segmenting and removing the interphase cells from the images of chromosomes. The interphase cell is a condensed mass of chromosome. This decreases the efficiency of the process by which the geneticist diagnose the genetic factor responsible for the genetic disease. This process is called karyotyping in which chromosome in the dividing cells are identified and displayed in a standard format. The method proposed is called Bit-Slicing in which the image are represented by pixels that happens to be sequence of bits, therefore every bit gives a binary image. This means that the original image is made of sub images containing 8 planes after using bit-slicing method. This means that 8-bit image contains 8 planes of 1-bit where plane 1 has the lowest order and plane 8 has the highest order bit from all pixels. After applying the method, image arithmetic is applied on the selected slices and filtered by region. Experiments were performed on chromosomes of 54 rat bone marrow. The image obtained from chromosomes where sliced into 8 place of gray levels. The planes from 0 to 3 did not give clear image hence the last three planes were selected. To extract the chromosome from the image, arithmetic operations were used. The filtering was done by region properties. The accuracy was found to be 90% on good quality images.

Zhiganag Li et al. [8] proposes an unsupervised algorithm for segmentation of Synthetic Aperture Radar (SAR) images which contains the homogeneous region and is based on the likelihood difference function. This function is derived from the Gamma distribution function. The over-segmentation region in the image is joined together with the help of similarity criteria. There are two steps involved for the segmentation, first is the rough segmentation in which the likelihood difference function is used as a similarity criterion and the second is a fine segmentation in which pixel level segmentation is done. So that a smooth edge can be obtained. The problem with SAR images is the back-scattering intensity which gives arbitrary variation due to interference multiple scattering within resolution cell of SAR images. This gives different changes to different gray values of SAR image for same object, therefore affects segmentation of SAR images. Using rough segmentation, the SAR images are divided into grids which follow fine splitting to separate border between homogeneous regions. The fine segmentation which is based on similarity distance algorithm is used to approach edge of homogeneity region. We need pixel-level segmentation and suitable similarity criterion to measure the commonality between two pixel and regions. The experiment was conducted on two SAR images with initial window size of 7x7 and the algorithm is consistent with the real boundary.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 9, September 2017

Jungeng Wu et al.[9] proposes a segmentation algorithm based on wavelet transformation and fuzzy clustering to characterize the infrared images of electrical equipment. Fuzzy C-means(FCM) clustering algorithm is very sensitive and gets easily affected by the initial clustering centers and also with the number of clustering which results in numerous problems like improper segmentation, etc. In FCM, the pixels with same characteristics are clustered together, so that their classification, number of cluster and fuzzy membership function can be found out. The wavelet transform is used because it can deal with analysis of images with different resolutions and gives the characteristics in plurality of scale space. This gives the feature information. The multiple scales obtained by wavelet multi-resolution analysis helps to reduce the amount of computation required by FCM. The DB4 wavelet family image wavelet decomposes the infrared images and the types of fuzzy clustering are automatically found. The clustering centers and the clustering number are found using a 2-dimensional histogram sampling which takes the FCM initialization sensitivity. The experiments show the accurate separation of the target object from the background.

Qiyao Yu and David A. Clausi et al.[10] proposes Iterative Region Growing Using Semantics(IRGS), an image segmentation method which focuses on two aspects. first is Graduated increased edge penalty (GIEP) functions which are used in the traditional Markov Random Field(MRF) context model for deriving objective functions. Second, it uses a region growing method for finding the solutions for the above mentioned objective functions. The IRGS focuses mainly on the edge strength information and is more stable for estimation of model parameters. It also provides a hint of possibility for the representation of image information which can be done hierarchically. This allows the feature information of various region and domain knowledge to be used in the segmentation process. IRGS gives a transition from standard Gaussian model to the MRF model hence providing more elegant and accurate estimation of the feature model. The region growing techniques are used to generate a hierarchical organization of pixels to give efficient optimization. This method was tested on several artificial images and Synthetic Aperture Radar(SAR) images.

## III. PROPOSED METHOD

### A. Watershed Segmentation

Main algorithm is primarily of watershed segmentation. We call different functions within the algorithm to facilitate the modified RAG-RKM methods. Flowchart is given below:

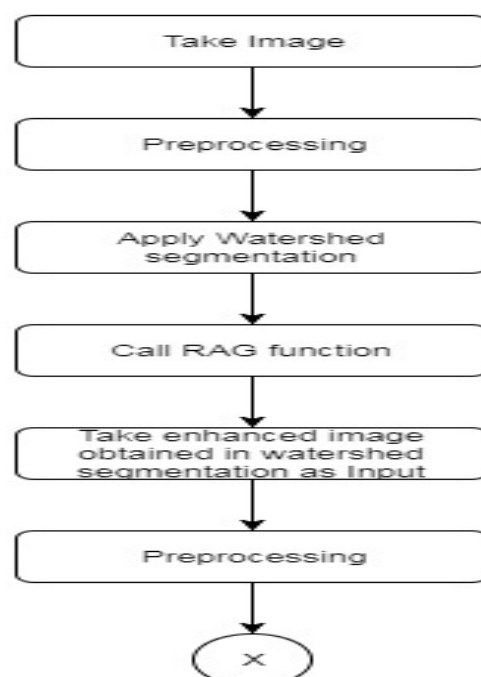


Figure 1: Flowchart of our algorithm.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 9, September 2017

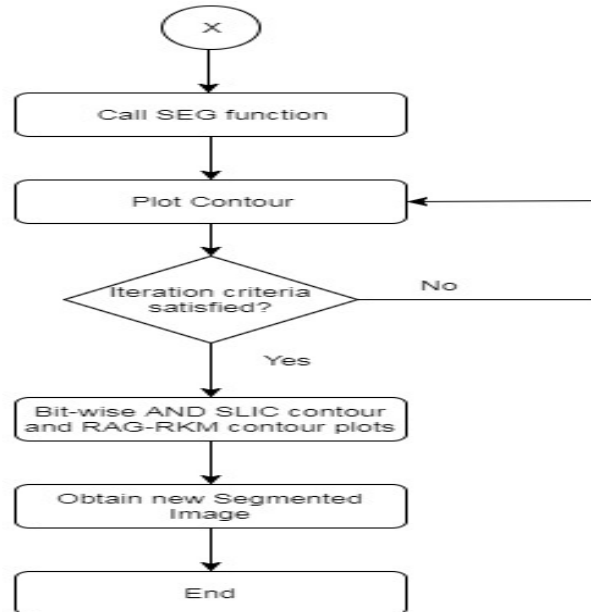


Figure 2: Flowchart of our algorithm (continued).

## B. Region Adjacency Graph(RAG)

This algorithm is used to find the centroid of different region obtained from initial watershed segmentation.

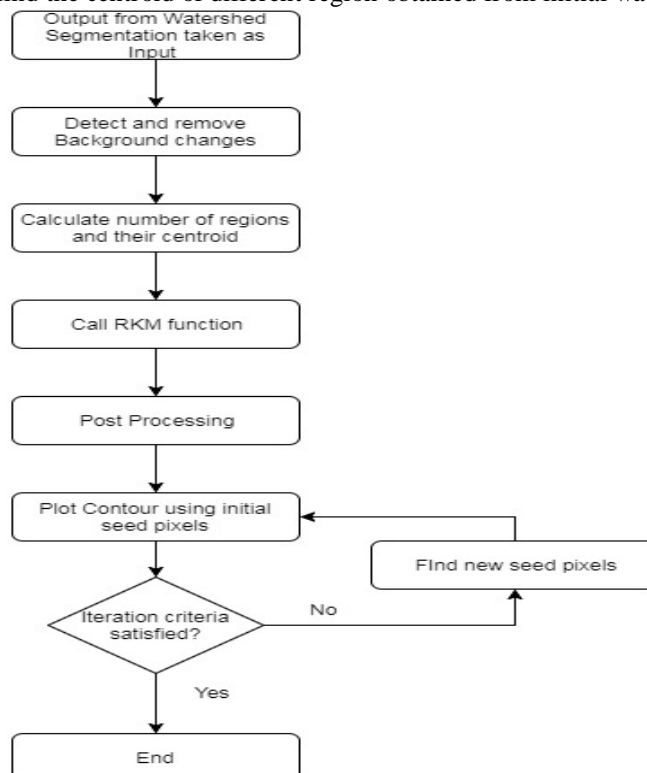


Figure 2: Flowchart of RAG.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 9, September 2017

After applying RKM we get the initial seed pixels and mask is obtained on which further processing is applied to plot the contour of the region.

### C. Region level k-means(RKM)

The objective of this algorithm is to check all the pixels of the image and then check all the regions and their respective pixels. We use it to find the initial seed pixels and mask for the plotting of contour.

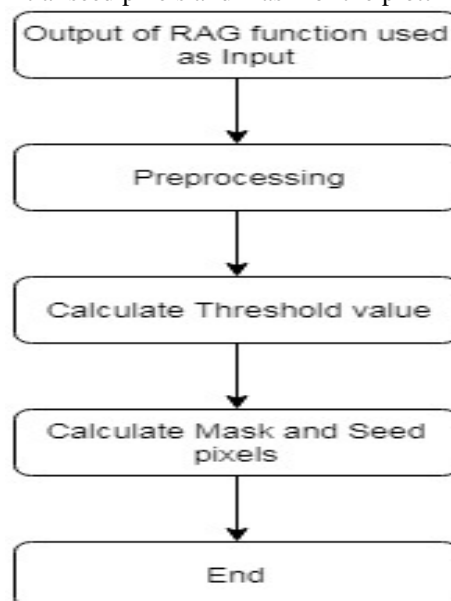


Figure 3: Flowchart of RKM.

### D. Simple Linear Iterative Clustering (SLIC) algorithm

This algorithm is mentioned in figure 1 as part of main algorithm. SLIC algorithm starts at the edge of the image and gradually moves towards the region of interest in the image. Various parameters like Neumann Boundary condition for movement of boundary edges, curvature of the region, area of the region, distance of the movement, angle of movement; are used in this algorithm which is defined in SEG. Its flowchart is given below:

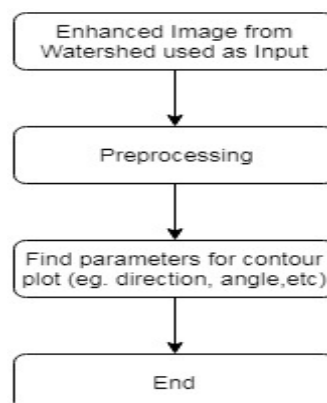


Figure 4: Flowchart of SEG.



# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 9, September 2017

## IV. RESULTS

### A. Parameter setting

These parameters are used in modified region merging using RAG-RKM.

(1) Deviation between pixels( $\tau$ )

$\tau = (9 * \gamma + 2) / 4$ , where  $\gamma$  is deviation scalar.

These parameters are used in SLIC.

(2) Angle( $\phi$ )

$\phi = \phi + \text{timestep} * (\mu * \text{distRegTerm} + \lambda * \text{edgeTerm} + \alpha * \text{areaTerm})$

where,  $\phi$  is initial angle,  $\text{distRegTerm}$  is used to calculate the distance between pixels,  $\mu$  is a scalar term used for calculating distance value,  $\text{edgeTerm}$  is used to calculate the edges value using gradient,  $\lambda$  is a scalar value used for calculating edges,  $\text{areaTerm}$  is used to calculate the area of circular area and  $\alpha$  is a scalar value.

### B. Software

The algorithm mentioned are implemented in MATLAB R2009a and tested on database of BSD300.

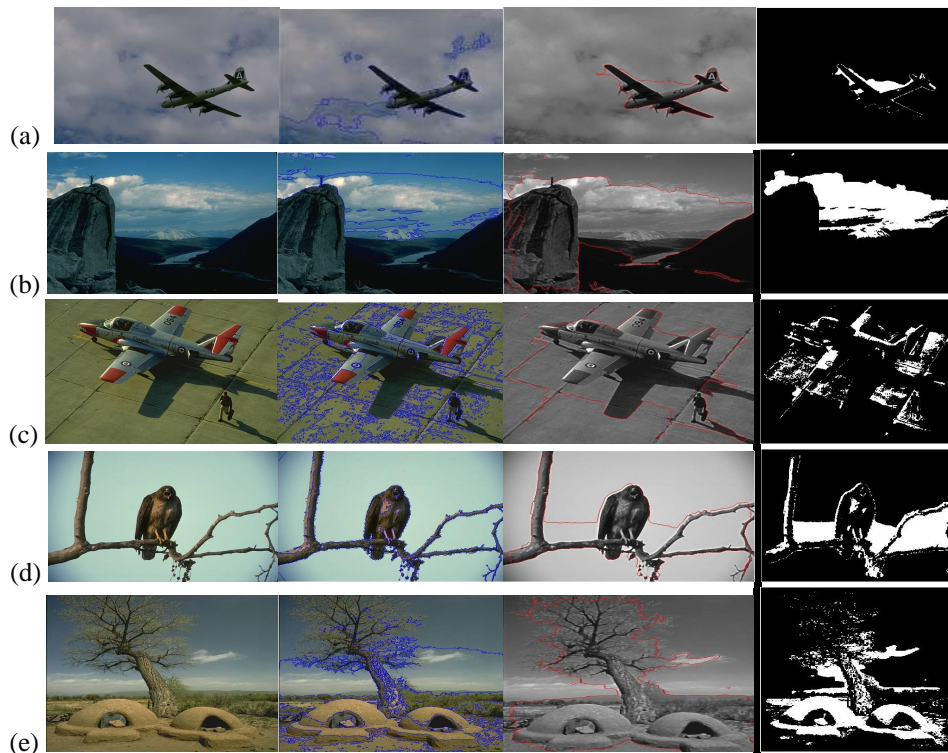
### C. Qualitative evaluation

The performance of our proposed algorithm is displayed in the figure 5 of Berkeley Database BSD300 and is figure 6 applied on random texture images

The segmented image is then measured against the ground-truth. We also calculate the true positive(TP) and false negative(FN) value

### D. Quantitative evaluation

For quantitative evaluation we using the parameters PRI(probabilistic rand index) and NPR(normalized probabilistic rand). We are also calculating the mean and variance which is shown in table below in Table 1 and Table 2 :



# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 9, September 2017

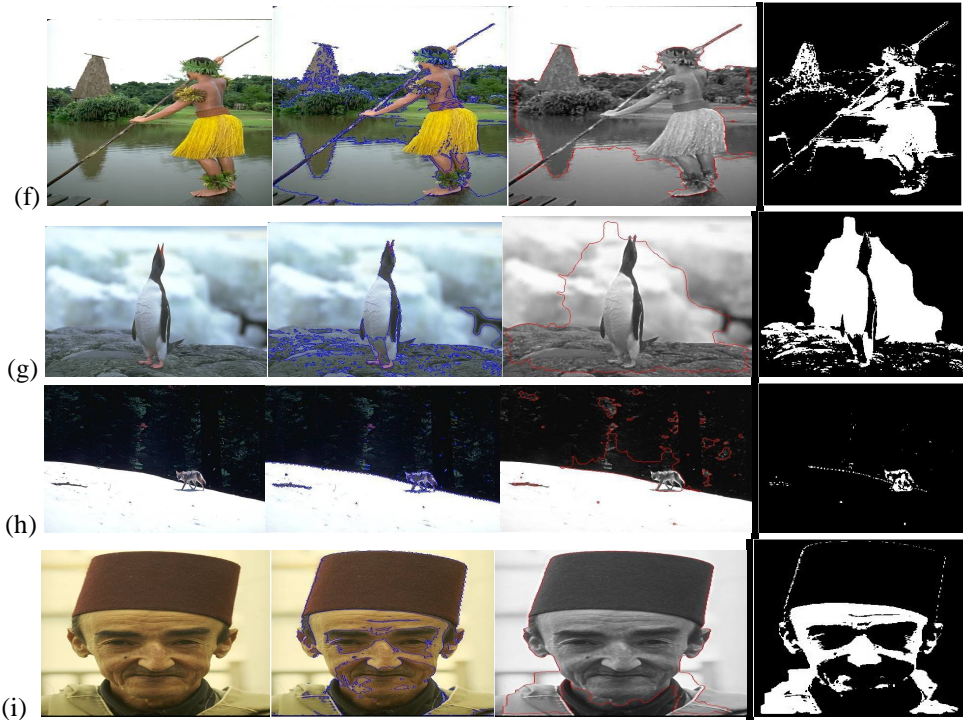


Figure 5: Testing of segmentation results (original, modified RAG-RKM, SLIC, Bit-wise OR of modified RAG-RKM and SLIC) on natural color images from BSD300.

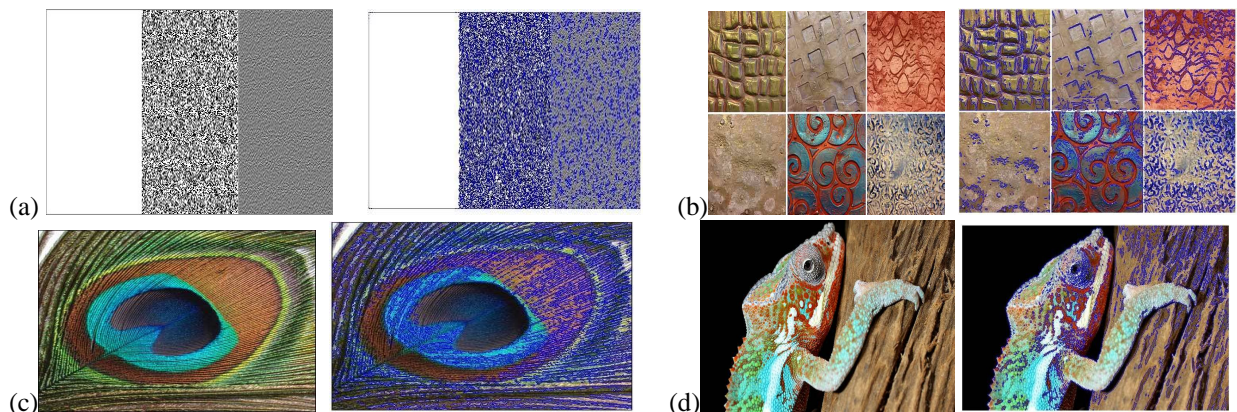


Figure 6: Testing of proposed algorithm on random color-texture images.



## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 9, September 2017

Image	PRI value	NPR value
a	0.9999	5.1813e-005
b	1.0000	1.9430e-005
c	1.0000	2.5907e-005
d	0.9999	8.4196e-005
e	1.0000	6.4766e-006
f	0.9997	2.9793e-004
G	0.9999	1.4896e-004
h	0.9999	6.4766e-005
i	1.0000	1.9430e-005

Table 1: Performance of proposed segmentation method based on PRI and NRI values.

Image	Mean value(PRI/NPR)	Variance value(PRI/NPR)
a	0.999948/1.0000	1.590577e-007 /1.590577e-007
b	0.999981/1.0000	6.207716e-008/6.207716e-008
c	0.999974/1.0000	8.020141e-008/8.020141e-008
d	0.999916/1.0000	2.956757e-007/2.956757e-007
e	0.999994/1.0000	1.346495e-008/1.346495e-008
f	0.999702/1.0000	7.989957e-007/7.989957e-007
g	0.999851/1.0000	8.384703e-007/8.384703e-007
h	0.999935/1.0000	1.979815e-007/1.979815e-007
i	0.999981/1.0000	4.014239e-008/4.014239e-008

Table 2: Mean and variance values of the PRI and NPR.

True positive value shows how close is our segmentation result from our proposed algorithm when compared with

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 9, September 2017

ground-truth. The value of true positive less than 1 indicates that there is error in our segmentation.

The proposed system also works to find the in-depth pattern in the texture including the border between the texture as shown in figure 6.

The laptop used for the implementation of this method is equipped with 2.50 GHz Intel core i5-3210M CPU and 8GB RAM.

## V. CONCLUSION

The major objective of this paper is to segment the image on the basis of color. This paper proposes two methods to increase the accuracy of the segmentation. Primarily we are using watershed segmentation to obtain initial segmentation. RAG is used to find the foregrounds in the image that is regions and finding centroids of this region. We are then applying RKM method to check all the pixels in image, pixels related to dedicated region and obtaining initial mask and seed pixels. Using this mask and seed pixels we are able to plot the contour. Then we apply SLIC algorithm to find more detailed information in the image like region area, curvature and angle of movement of contour. The output of two algorithms put together to increase the overall accuracy of the segmentation.

The proposed algorithm gives satisfactory result. The proposed algorithm mentioned above outperforms and obtained color segmentation with high accuracy.

Also, when the algorithm was applied on random texture images the result found was that the border between the regions of the texture images where segmented and also the pattern inside the texture was also segmented.

## REFERENCES

- [1] A.K. Qin and David A. Clausi , "Multivariate Image Segmentation Using Semantic Region Growing With Adaptive Edge Penalty", IEEE Transaction on Image Processing, Vol. 19 August 2010, pp 2157-2169.
- [2] Huisi Wu, Yilin Wu, Shenglong Zhang, Ping Li, Zhenkun Wen , "Cartoon Image Segmentation Based on Improved SLIC Superpixels and Adaptive Region Propagation Merging", 2016 IEEE International Conference on Signal and Image Processing.
- [3] Ranran Dong ,Bo Wang, Shuai Li, Zhiqiang Zhou,Sun Li, Zhongkai Wang, " Interactive image segmentation with color and texture information by region merging", 2016 Chinese Control and Decision Conference(CCDC).
- [4] Rostom Kachouri, Mahmoud Soua, Mohamed Akil, " Unsupervised Image Segmentation Based on Local pixel Clustering and Low-Level Region Merging", International Conference on Advanced Technologies for Signal and Image Processing - ATSIIP'2016, Monastir, Tunisia.
- [5] Tingting Lan, Shanshan Gao, Jing Chi, Yuanfeng Zhou," Object Contour Extraction Based Saliency Detection and Automatic Region Growing", 2016 International Conference on Virtual Reality and Visualization, pp 57-64.
- [6] Mohamed Ben Gharsallah and Ezzedine Ben Braiek," Image segmentation for defect detection based on level set active contour combined with saliency map", International Conference on Sciences and Techniques of Automatic control & computer engineering, Monastir, Tunisia, December 2015, pp 338-392.
- [7] Mona A. S. Ali, M.I Shaalan, Aboul Ella Hassanien, Tai-Hoon Kim," A Simple approach for Segmentation and Removal of Interphase Cells from Chromosome Images", 2015 International Conference on Computer and Computing Science, pp 3-8.
- [8] Zhigang Li, Zhen Yang and Huilin Xiong, " Homogeneous Region Segmentation for SAR Images Based on Two Steps Segmentation Algorithm", 2015 International Conference on Computers, Communications, and Systems, pp196-200.
- [9] Junpeng Wu, Yan Wang, Juan Lou, Min Li, " Infrared Image Segmentation for Power Equipment Failure Based on Fuzzy Clustering and Wavelet Decomposition", 2015 International Conference on Computational Intelligence and Communication Networks, pp 1274-1277.
- [10] Q. Yu and D. A. Clausi, "IRGS: Image segmentation using edge penalties and region growing," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 30, no. 12, pp. 2126–2139, Dec. 2008.
- [11] The Berkeley Segmentation Dataset and Benchmark (BSD300), <https://www2.eecs.berkeley.edu/Research/Projects/CS/vision/BSDS300/html/dataset/images.html>