International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume-5, Issue-4, July-2017
DOI:10.21276/ijircst.2017.5.4.4

Frequency Domain Digital Image Segmentation based on a Modified kMeans

Divya, Mr. Pawan Kumar Mishra

***Abstract*—The segmentation of image is the basic thing for understanding the images whether it is a color image or gray scale image. It is used in the various image processing applications, computer vision, etc. In this thesis work we have used multiple clustering approaches to segment the image in our initial step like Normalized cut, kMeans, and Mean shift. The main aim was to obtain feature extraction, to reduce convergence, to reduce computation time, and to overcome the over segmentation caused by the noise, also incorrect spread of intensity. Hence the optimal solution has been derived through the Modified kMeans through which the feature extraction and the separation of overlapping objects were evaluated by making use of wavelet transform and computation time was reduced by considering approximation band coefficients of DWT contribution in an image through which overall performance was improved. Proposed work has been implemented in MATLAB environment.**

***Index Terms*— Image Segmentation, Normalized Cut, Mean shift, kMeans, Modified kMeans.**

I. Introduction

Digital image processing and analysis exhibit a remarkable growth in recent years. It concerns with the transformation of an image to a digital computer. Both the input and output of digital image system are digital images which can be achieved through image processing. Digital image processing automates different tasks together with the help of various tools and thus by making use of evolutionary algorithms the complex image is converted into a simple image. Because of this reason, the image segmentation process is considered to be important for digital image processing. Image segmentation refers to the process of partitioning a digital image into multiple segments i.e. a set of pixels, pixels in a region are similar following some homogeneity criteria such as color, intensity or texture, so as to locate and identify objects and boundaries in an image [1]. To obtain the feature extraction for image segmentation the technique of wavelet transformation was introduced in this paper.

A wavelet is a "small wave" which has its energy concentrated in time and which gives a tool for the analysis of transient, non-stationary, or time-varying phenomena about analyzing signal with short duration finite energy functions [2]. Wavelets are the functions that fulfill certain mathematical requirements and are generally used in representing data or other functions. Wavelet algorithms process data at different scales or resolutions. Temporal analysis is achieved with a contracted, high-frequency version of the prototype wavelet, while frequency analysis is achieved with a dilated, low-frequency version of the same wavelet. Thus in this paper, we had presented a Modified kMeans technique with the wavelet based transformation in the frequency domain.

II. Literature Survey

D. Comaniciu and P. Meer [3], the authors of this paper had proposed a non-parametric technique to delineate arbitrarily shaped clusters and for the analysis of complex multimodal feature space. As applications, the algorithms for low-level vision tasks, discontinuity preserving smoothing, and image segmentation were also described by the author. In these algorithms, the user set the parameter and the gray images or color images are accepted as input. The extensive experimental results and excellent performance were illustrated.

Tao W B, Jin H, Zhang Y M [4], a novel approach was developed by the authors that provides an effective and robust segmentation of color images through mean shift and normalized cut partitioning methods. It requires low computational complexity and was therefore feasible for real -time image segmentation. In addition, the author used segmented regions instead of image pixels and reduces the noise and enhanced the image segmentation performance. The proposed method was examined and demonstrated through a large number of experiments using color natural scene images.

W. X. Kang, Q. Q. Yang, R. R. Liang [5], this paper reviews and enumerates the image segmentation algorithms and then the author presented the basic evaluation approaches for the algorithms. The author also discussed the prospects of image segmentation and through experimental results found their valuable characteristics.

Grigorious .F.Tzortz Aristisdis C.Likas [6], the author proposed the global kernel means algorithm, a deterministic algorithm for optimizing the clustering error in feature space that employs kernel-means as a local search procedure in order to solve the clustering problem. The methods have been tested on several diverse data sets in order to confirm their broad applicability and draw reliable inferences.

Gurbinder Kaur, Balwinder Singh [7], an efficient segmentation that was achieved by wavelet transform was discussed in this paper with consideration of DWT band approximation. The proposed algorithm was much better in terms of computation time and image quality index.

Manuscript received 15 July, 2017.

Divya, Department of Computer Science and Engineering, Faculty of Technology, Uttarakhand Technical University, Dehradun, India

Mr. Pawan Kumar Mishra, Department of Computer Science and Engineering, Faculty of Technology, Uttarakhand Technical University, Dehradun, India

Overall the study concludes that it is important to extend algorithms that reduce convergence time, computation time and are much superior in terms of image quality index in comparison to the existing methods.

Samer Kais, Jameel Ramesh, R.Manza [8], the color image segmentation by extracting the optimal features which discriminate between regions was discussed by authors of this paper. Using two dimensions wavelet transforms to decompose the image into sub-bands channels and made up the of a smooth image and convert the image into NTSC color space enables us to quantify the visual differences in the image, and clustering technique was used to partition the image into a set of "homogeneous" regions was also proposed.

Sidhu Kanwaljot Singh, Khaira Baljeet Singh, Virk Ishpreet [9], the authors presented the image de-noising using the Haar and Daubechies transforms. After de-noising the level of soft and hard threshold has been selected to reduce the noise in the image. Then the author has calculated and compared the PSNR of the image for the wavelet and then assigned the values which give better results. It is found that Daubechies wavelet is more efficient than that of Haar wavelet for removing the certain level of noise.

Navneet Kaur, Gagan Jindal [10], in this paper the authors had presented different techniques that automatically segment and locate the lesion in body organs, especially brain and lung CT/MRI images. These techniques overcome the accuracy and sensitivity limitations of the current solutions. More attention is being paid to the semi-automatic segmentation methods on Lesion measurements in order to avoid the observer variability and therefore to increase the accuracy. The region based labeling drastically reduced the segmentation time.

X. Cui, G. Yang, Y. Deng and S. Wu [11], an enhanced watershed algorithm for image segmentation has been proposed by the author of this paper. By the use of watershed, algorithms get the marks on the forefront and background objects obtain better partition. At the end, the watershed which is enhanced by the gradient images will have image segmentation, in such aspects as outlined eliminate over segmentation and regional positioning has a very good segmentation effect.

Divya, Pawan Kumar Mishra [12], in this paper image segmentation technique i.e. Mean shift, kMeans, Normalized cut were introduced by authors and the results were analyzed and compared in terms of the various parameters like color similarity, number of clusters, kernel bandwidth etc.. The results obtained were highly efficient.

III. Approach

Wavelet transform possess a multi resolution capability. To transform images two-dimensional wavelets can be used or by applying the one-dimensional transform to the rows and columns of the image one after another as separable two-dimensional transform. Wavelets offer a mathematical way of encoding numerical information or data such that it layer according to a level of detail. This layering not only assists the progressive data transmission mentioned above but also approximations used at various intermediary stages.

Wavelet transform of a signal means to describe the signal with a family of functions. In two-dimensional images, the intensity of edges can be enhanced in each one-dimensional image.

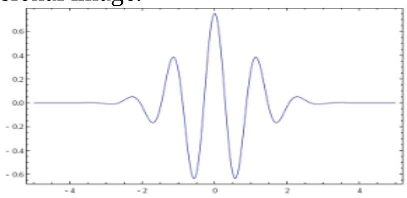


Fig 1. Wavelets example

There are generally three classes of wavelet transform: Discrete wavelet transforms (DWT), Continuous wavelet transforms (CWT) and Multi resolution based wavelet transform. DWT works on two functions, namely scaling function and wavelet functions. The analysis of signal at different scales is done by using the filters of different cut off frequencies. This decomposes the signal into different frequency bands, which are passed through the series of filters to analyze the high frequencies and low frequencies. The images shown below were used as the input test images.

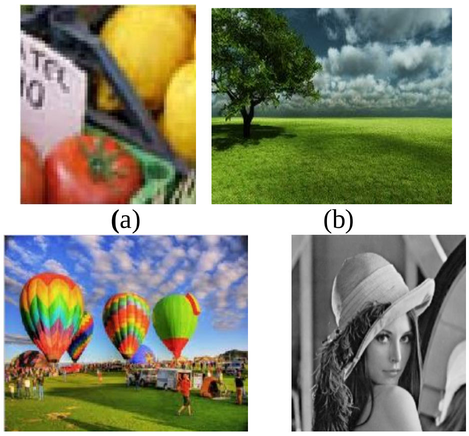


Fig 2. Input Test Images

In this paper, the principles of wavelet transform i.e. Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT) were adopted and the properties of most used Gaussian low pass filter has been considered. The wavelet transformation used is straightforward which includes averaging and differencing terms, placing away detail coefficients, disposing of information, and re-forming the network. Following subsections describe algorithm of image segmentation using wavelet transform.

A. Image Feature Extraction

The algorithm of image features extraction involved the decomposition of approximation coefficients. Feature matrices were formed by computing the co-occurrence matrix features energy and contrast given in Eq. (1) and (2).

$$Energy = \sum_{i,j=1}^{N} c_{i,j}^2 \quad (1)$$

$$Contrast = \sum_{i,j=1}^{N} (i-j)^2 \, c_{i,j} \quad (2)$$

ISSN: 2347-5552, Volume-5, Issue-4, July-2017
DOI:10.21276/ijircst.2017.5.4.4

B. Matrix Difference

A new matrix with differences is obtained by calculating the difference between the value by value of features both in horizontal and vertical directions.

C. Filtering

The differences could appear in the form of artifacts or spurious spots. The spots and noise could be formed that can be removed by applying a filter. For that create a filter of a suitable radius and then apply for a segmented image to minimize and efface the image.

D. Thresholding

The thresholding is applied on the processed image by global image threshold and a black and white image is obtained. In an image $a[m,n]$ to apply a brightness threshold the parameter θ is to be selected. It follows as:

If $a[m,n] \geq \theta \quad a[m,n] = object = 1$
Else $a[m,n] = background = 0$

It shows that we are focusing on lighter objects on a dark background.

Otherwise, use

If $a[m,n] < \theta \quad a[m,n] = object = 1$
Else $a[m,n] = background = 0$

Some gray value histogram threshold value initially starts from. $\{h[b] | b = 0,1,\ldots,2^{B-1}\}$

IV. Initialization Of Parameter

With the goal to implement the algorithm in MATLAB software in respect to segment the image using wavelet transformation on color as well as gray images, it is necessary to introduce the parameters also that has been used for the purpose to perform segmentation using wavelet transformation process. Parameters used are described below.

Kernel bandwidth: This parameter depends upon the contents of the image and noise. For a similar type of image, it will not vary and values can be found out through experiments by varying it in between 1 and 10.

Contrast threshold: Low-value means detection of low contrast objects, high value means detection of high contrast objects. The contrast threshold and kernel bandwidth are the parameters that change according to the image.

Morphological Smooth Radius: Morphological disk radius set to 1 if the image is noisy, otherwise it can be set to 0. The obtained blobs can be refined through the morphological operation.

Normalization: Set the parameter objects lighter to 1 for the objects that are lighter than the background. Otherwise it is set to 0. For this the two conditions i.e. mu2>mu5 and mu2<mu5 were applied on the image that is to be segmented and implemented as:

```
i=strcmp(wbis,'mu2>mu5');
if (i==1)
    wbis=1;
else
    wbis=2;
```

Segmented Region: This output parameter shows the segmented regions that are obtained by applying the segmented techniques.

V. Modified Kmeans Algorithm

This section shows the step by step implementation procedure used in this thesis. The implementation of the proposed method i.e. Segmentation based on a Modified kMeans was done in MATLAB environment.

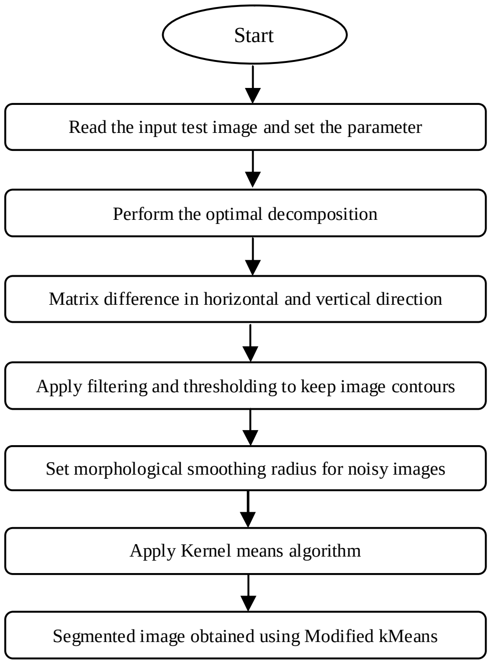


Fig 3. Flowchart for Modified kMeans

The algorithm has the following steps.

A. For Segmentation

1. Calculate segmented band by taking the difference value by value of matrix features both in vertical and horizontal directions.
2. The spots and noise could be formed within the same region and the high difference of value can be appeared. The spurious spots can be removed by applying an average filtering.
3. Minimize the segmented image and efface of image.

B. For Normalization

1. Select the input image from the Graphical user interface to process the image segmentation.
2. Adjust the input parameters for processing i.e. normalization parameter and select the condition specified in it.

Check If (Objects are lighter than background)
Set, Object Lighter = 1;
Set, mu2>mu5;
Otherwise set 0;
Fill holes to merge plateau regions into the surrounding objects regions.
Else
Filter with morphological disk to discard noisy objects.

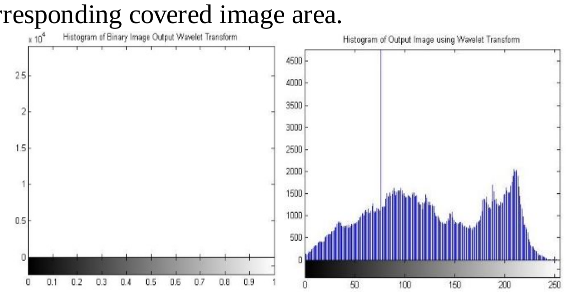
3. Check the results using the output parameters i.e. segmented region, execution Time etc.
4. Compare the results.

VI. Performance Evaluation

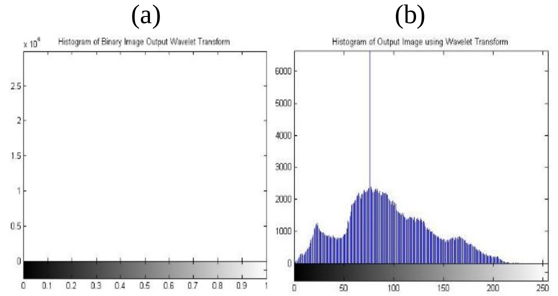
It constitutes that the proposed method generates comfortable segmentation results and appropriate to general color and gray scale image applications. Figure 4 below shows the segmentation results obtained on Test Images with kMeans and Modified kMeans.

Fig 4. Results obtained using Modified kMeans
(a) Input Test Images
(b) Normalization parameter: mu2> mu5
(c) Normalization parameter: mu2< mu5

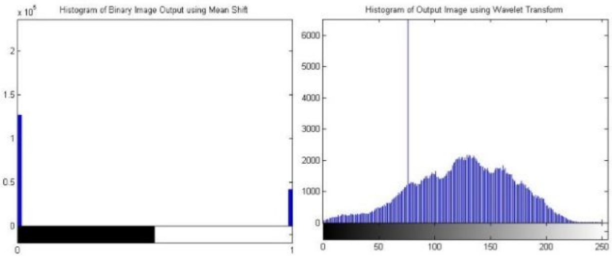
The Figure 4 above shows the input image, the segmentation results obtained by using modified kmeans algorithm with normalization parameter mu2>mu5 and normalization parameter mu2<mu5. Input image used is a colored image which shows segmentation of clouds and sky based on parameter values that were selected and other corresponding covered image area.



(a) (b)



(c) (d)



(e) (f)

Fig 5. Result showing Histogram of input and output images used

(a) Histogram for Binary Image: Test Image 1
(b) Histogram for Output Image through modified kmeans: Test Image 1
(c) Histogram for Binary Image: Test Image 2
(d) Histogram for Output Image through modified kmeans: Test Image 2
(e) Histogram for Binary Image: Test Image 3
(f) Histogram for Output Image through modified kmeans: Test Image 3

Figure 5 shows the histogram of the binary image that was formed before the segmentation and the output image histogram of the input image. The binary image histogram displays the occurrence of black and white color obtained during binary image conversion. The Output image histogram displays the occurrence of the image color.

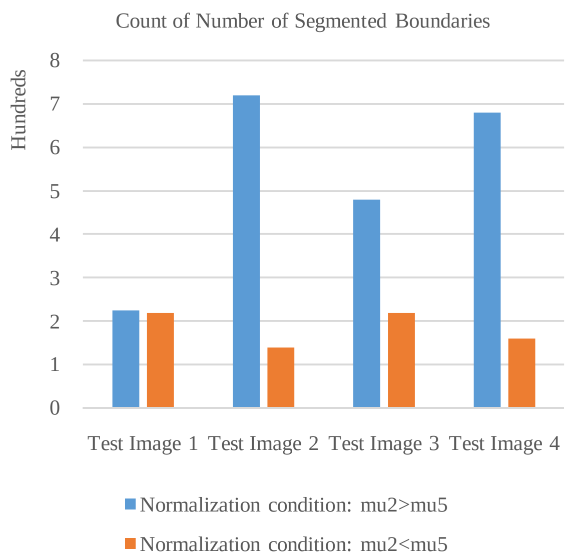


Fig 6. Count of Segmented Boundaries using Normalization parameter

Further, the counts of the segmented boundaries obtained were shown in the above Figure 6 for the normalization parameter used in the Modified kMeans algorithm.

Figure 7 shows the execution time that was evaluated for the above methods i.e. Modified kMeans with the other algorithm like Mean shift, Normalized cut, kMeans.

International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume-5, Issue-4, July-2017
DOI:10.21276/ijircst.2017.5.4.4

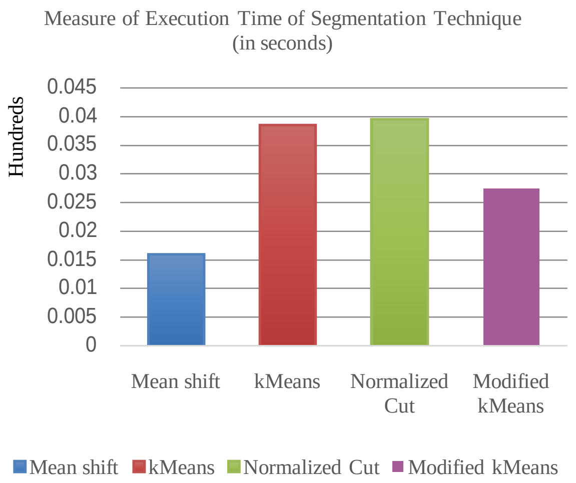


Fig 7. Comparison of Execution Time by different segmentation Technique on Test Image 1

In Figure 8 the comparison of the execution time that was evaluated during the whole process has been shown. In the figure the comparison is shown between the Mean shift algorithm, Normalized cut, kmeans and Modified kmeans algorithm. The Figure shows that the segmented region obtained by the mean shift were less in comparison, while the kmeans has an average number of segmented regions. The segmented regions obtained by Modified kmeans were much more than the other algorithms.

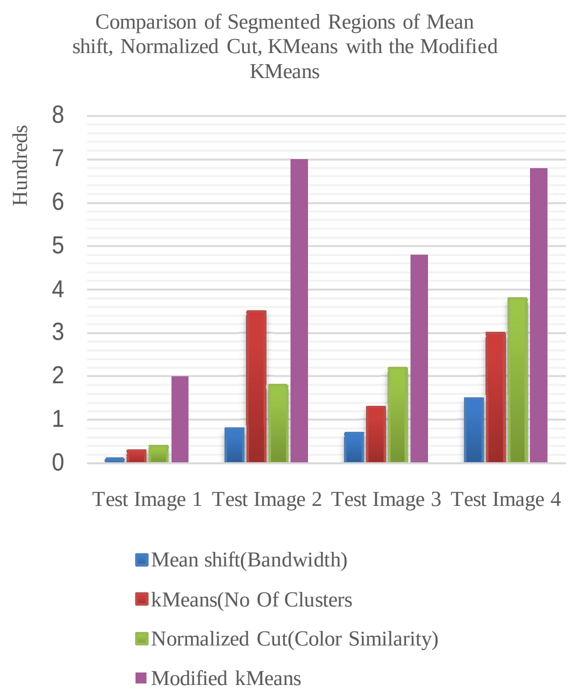
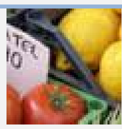
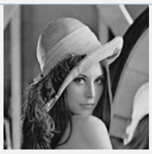


Fig 8. Comparison of Segmented Region of different segmentation Technique on used Test Images

The below figure 9 shows the comparison of the execution time of Mean shift, Normalized cut, kMeans with the Modified kmeans. Table 1 shows the output images obtained through segmentation applied on different input color and gray scale images.

Table 1: Table showing Image segmentation output images using different techniques

Input Test Image	kMeans	Modified KMeans
 Test Image 1		
 Test Image 2		
 Test Image 3		
 Test Image 4		

The below figure 9 shows the comparison of the execution time of Mean shift, Normalized cut, kmeans with the Modified kmeans. That shows that on an average the execution time of Modified kmeans is very less than the other used technique.

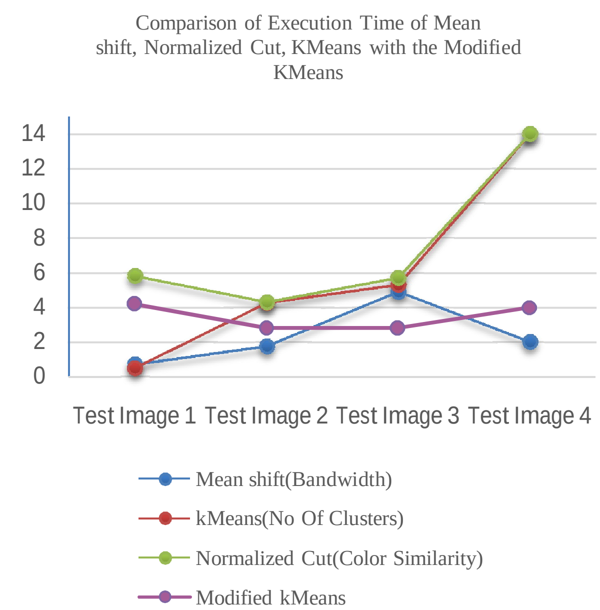


Fig 9. Comparison of Execution Time of different segmentation Technique on used Test Images

VII. Conclusion

In this paper, we presented a new method of segmentation for color and gray scale images. We used Modified kMeans approach for segmentation in the frequency domain. The proposed technique was compared with other relevant segmentation approaches and found to be better than other methods, both in terms of quality, speed and convergence rate. We have used multiple input parameters like kernel bandwidth, the number of clusters; color similarity, normalization parameter and output parameters like segmented regions and the execution time to evaluate the performance of various segmentation algorithm. In future, the above approach can be performed and improved through additional parameters like Global consistency value etc.

ACKNOWLEDGMENT

The work has been supported by the Department of Computer Science and Engineering, Faculty of Technology, Dehradun.

REFERENCES

[1] Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 2nd ed., Beijing: Publishing House of Electronics Industry, 2007.

[2] P.M.K. Prasad, D.Y.V. Prasad, G. Sasibhushana Rao Prof., "Performance analysis of orthogonal and biorthogonal wavelets for edge detection of xray images", Procedia Computer Science, International Conference on Recent Trends in Computer Science & Engineering, Vol. 87, pp 116-121, 2016.

[3] Comaniciu and P. Meer, "Mean shift: A robust approach towards feature space analysis", IEEE Transactions on pattern analysis and machine intelligence, 2002.

[4] Tao W B, Jin H, Zhang Y M, "Color image sSegmentation based on mean shift and normalized cuts", IEEE Transactions on Systems, Man, and Cybernetics-Part B: Cybernetics, 37(5):1382-1388, 2007.

[5] W. X. Kang, Q. Q. Yang, R. R. Liang, "The Comparative Research on Image Segmentation Algorithms", IEEE Conference on ETCS, pp. 703-707, 2009.

[6] Grigorious .F.Tzortz Aristisdis C.Likas, "The global kernel K-Means Algorithm for clustering in feature Space", IEEE Transactions on Neural Networks, vol 20, 2009.

[7] Gurbinder Kaur, Balwinder Singh, "Intensity Based Image Segmentation using Wavelet Analysis and Clustering Techniques", Published in IJCSE, Indian Journal of Computer Science and Engineering, Vol.2, NO.3, 2011.

[8] Samer Kais, Jameel Ramesh, R.Manza, "Color Image Segmentation using Wavelets", International Journal of Applied Information Systems (IJAIS)-ISSN: 2249-0868, Vol. 1 No.6, 2012.

[9] Sidhu Kanwaljot Singh, Khaira Baljeet Singh, Virk Ishpreet, "Medical Image De noising In The Wavelet Domain Using Haar And Db3 Filtering", International Refereed Journal of Engineering and Science (IRJES) ISSN: 2319-1821, Vol. 1, pp.:001-008, Issue No. 1, 2012.

[10] Navneet Kaur, Gagan Jindal, "A Survey Of K Means Clustering With Modified Gradient Magnitude Region Growing Technique For Lesion Segmentation", International Journal Of Innovations In Engineering And Technology, 2013.

[11] X. Cui, G. Yang, Y. Deng and S. Wu, "An Improved Image Segmentation Algorithm Based on the Watershed Transform", IEEE, pp. 428—431, 2014.

[12] Divya, Pawan Kumar Mishra, "Implementation of Color-based Image Segmentation by Clustering Methods", International Journal of Computer Science and Mobile Computing, Vol.6 Issue.3, pp. 1-8, 2017.

Author's Profile

Divya is an M.Tech student of Department of Computer Science and Engineering, Faculty of Technology, Uttarakhand Technical University, Dehradun. She has published research paper in International Journal of Computer Science and Mobile Computing.

Mr. Pawan Kumar Mishra is an Assistant professor and Head of Department of Computer Science and Engineering, Faculty of Technology, Uttarakhand Technical University, Dehradun. He has published various research papers in national and international journals.

