IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 19, Issue 5, Ver. V (Sep.- Oct. 2017), PP 42-50
www.iosrjournals.org

Comparative Study of Watershed and K means Clustering in Brain Tumour Identification

Garvit Pareek[1], Vinay. M[2]
[1]*MCA (Computer Science) Christ University, Bengaluru, India*
[2]*Assistant Professor of Computer Science Christ University, Bengaluru*
Corresponding Author: Garvit Pareek

Abstract: *The core objective of our paper is to compare K means clustering and watershed algorithm using MATLAB tool. The comparison is based on their performance, accuracy, and its geometrical dimension. A Brain tumour is one of the major cause of death in current space. Many researchers and scientist are constantly working from last two decades and proposing, unlike algorithm which can be integrated with biotechnology field for effective results. MRI image plays a predominant role in identifying and extracting the tumour part. It offers better results of various soft tissues as compared to CT scan, X-ray, and Ultrasound. Segmentation of image is a grueling task because of intensities. It is implied that patient survival can be increased if tumour is identified exactly at an early stage. A Brain tumour is an assembly of deviant cells which causes irritation, brain swelling, change in hearing and vision, change in muscle movement etc. In this paper, we are proposing the most effective algorithm for the tumour detection and identification. For implementation purpose, we used MATLAB toolbox of image processing.*

Keyword *Terms: Brain tumour, K means Clustering, Watershed, MRI, pre-processing.*

Date of Submission: 04-10-2017 Date of acceptance: 02-11-2017

I. Introduction

An unfit human body can be thrashed by numerous diseases. Better health is the most basic requirement and integral satisfaction of every single individual and it doesn't come in legacy. A Brain tumour is not much different in this regard.

The Human body is made up of various types of cells. The Brain is the most sensitive part of a human being formed with numerous cells. Its size, location, structure varies from person to person. It is a major cause of death in medical discipline. Since its very complex in nature, tumour identification and extraction is a complex process. MRI images play an indispensable role in analyzing the image both qualitative and quantitative such as computing precise shape and size. Nature has firmly shielded the cerebrum inside the skull which proves to be an obstacle in the study of brain. So the tool for tumour detection must be directed at intracranial cavity.

Tumour is basically an anomalous growth of cells. If not operated at an early stage, it may abruptly grow and affect the neighboring cells. Tumour can be categorized into 3 types:

1.) Benign tumour: Least harmful and doesn't grow abruptly in neighboring cells. It doesn't lead to death. Moles can be the perfect instance of a benign tumour.

2.) Pre Malignant tumour: It can be defined as a pre-cancerous stage. It a stage which is prior to a malignant tumour. If not operated on time, it will convert to the malignant tumour which will eventually result in the death of a person.

3.) *Malignant tumour:* The former is defined as a slow growing tumour that will damage only a particular area of the brain. The Premalignant tumour is a cancer stage where a tumour becomes worse with the passage of time. It exhibits the pressure on another close by cells also. It causes the death of a person. The term can be divided into 2 parts: "mal" which means worse and "ignis" means blaze.

Medical Resonance Imaging is basically a technique used by scientist and doctors to closely examine the brain structure, ankle from deep inside. MRI technique is widely used in the biotechnical field to derive the fine details of an inward body structure. CT scan makes use of ionizing radiation whereas magnetic field is used by MRI technique to line up nuclear magnetization and then the radio frequency alters the position of the magnetization which can be easily identified by the scanner. These magnetic field helps to study tiny contrast in tissue. In MRI images, tumour cells appearing as hypo or ISO tense. Hypo means darker than brain tissue and ISO means same intensity as of brain tissue and perhaps, the reason why it is so extensively used.

Pre-processing is done to improve image quality. It limits the blurring effect of an image. Noise is reduced and fine details become clearer. The first step is to convert the digital image into gray scale of the gray scale of 255*255 size. Pre-processing sharpens the image and segmentation help to detect the edges. The following steps can be followed in order to achieve high-quality image:

(a) *Noise removal:* Gaussian filter helps to remove the noise from an image. Under certain conditions, the linear filter can be used to reduce noise while preserving the edges. Median of the neighboring pixels are used as the value of the pixel. The best part of the median filter is that it's not prone to outliers.

(b) *Image sharpening:* High pass filter is used to serve this purpose. High pass filter provides sharp edges by enhancing the contrast between two or more adjacent areas. The Gaussian filter can be used for this purpose.

(c) *Segmentation:* Segmentation is a process of extracting crucial features from digital image and information can be derived from it. In this, a digital image is partitioned into sets of pixels. Partition is done in such a way that each region is a non-intersection. Each region should be homogenous. The sole intention of segmentation is to separate the picture into totally unrelated and depleted areas.

(d) *Morphological Operations:* Morphological operation is the last step where the pixel with the highest intensity is extracted out. At this step, only the tumour part is visible with white background. The Morphological operation can be only applied to binary images. Various MATLAB commands used to serve this purpose include Strel, Imerode, Imdilate

II. Literature Review

Danyal Maheshwari and Ali Akber Shah et al, in their paper "Extraction of Brain Tumour in MRI images, using Marker-Controlled Watershed Transform Technique in MATLAB" have proposed a technique, called Marker constraint watershed transform, based on MATLAB for purpose of tumour extraction. In this paper, a grayscale image is converted into gradient magnitude and the resultant image have exposed to various morphological operations for noise removal. Open and close by reconstruction, erosion, dilation, and thresholding have been used for foreground marker, background marker and object boundaries. Finally, the tumour is extracted out from the segmented output image. It involves 3 steps – pre-processing of an image, marker computation and final watershed transformation. The Marker-controlled watershed is better than conventional approach in the way that it extracts the irregularity and provides exact results.

Yogita Sharma and Parminder Kaur in their paper "Detection and Extraction of a brain tumour using K-Means Clustering and watershed Algorithms" have compared both the algorithm in terms of time consumption. They have proposed a new technique called kernel-based k means algorithm for the problem where objects are adjacent to each other and we need to separate them from each other. The original image is converted into grayscale and the gradient is computed. Internal and external markers are used to the separate foreground and background markers and then final image is examined. Kernel- based k means has the advantage of calculating various parameters.

Rajesh C. Patil and AS Bhalachandra in their paper "Brain tumour extraction from MRI images using matlab" have described the methodology to identify and separate the tumor from MRI image. This paper has incorporated various morphological operations and segmentation techniques. Provided MRI image is converted to a grayscale image and various filter have been applied. A image is sharpened using high pass filter. The brightness of kernel pixel is increased more compared to neighbor pixels. A Median filter is used to preserve the edges while removing noise from the image. Watershed segmentation has been applied to threshold segmentation whose input image is processed through filters. Finally, morphological operations are applied such that pixel have non zero value if the test is successful.

Anam Mustaqeem, Ali javed, and tehseen Fatima et al, in their paper "1an efficient Brain tumour detection Algorithm using watershed and thresholdbased segmentation" have proposed tumour detection algorithm using segmentation and morphological operators. It constitutes of three section – Pre-processing, processing and Post-processing. Median filter and Gaussian filter have been applied to enhance object boundaries and sharpen the image as pre-processing. The threshold is used to highlight the tumour and watershed is applied to extract it. Imerode and Imdilate operators have been used to provide the final output.

Neha Baraiya and Hardik Modi in their Paper "Comparative Study of Different Methods for Brain Tumour Extraction from MRI Images using Image Processing" have compared the accuracy of Region based segmentation, thresholding, and watershed. For better results, noise has been removed using pre-processing. Segmentation using all 3 techniques are performed and accuracy has been evaluated by comparing the actual tumour with a segmented tumour. Each of the algorithms is implemented on same computer and accuracy rates are 87.4, 91.3 and 92.7 respectively. Its quiet implied that watershed is the most effective algorithm in terms of accuracy.

V. Sagar Anil Kumar and T. Chandra Sekhar Rao et al, in their paper "Brain Tumor Extraction by KMeans Clustering Based On Morphological Image Processing" have combined segmentation with k mean clustering in order to improve the quality of diagnosis. To improve the quality, slight modification has been performed to K means clustering. The modification done is to lessen intensive data computation that takes places at each iteration. It will make the algorithm more fast and efficient. The input image is divided into 4 regions. To avoid misclassification, the elliptical object must be removed. The unsupervised approach is better than supervised as it is less prone to error. Moreover, the supervised approach requires lots of processing which makes the process complicated and time-consuming.

Richa Aggarwal and Amanpreet Kaur in their paper "Comparative Analysis of Different Algorithms for Brain Tumor Detection" have compared five segmentation techniques namely histogram, FCM, K means, Region growing and Watershed. The histogram is the most effective algorithm in tumour extraction compared to others as it requires only one pass through the pixels. Histogram takes all the pixel values and builds a rectangle. Since it is easy to understand the cluster location can be identified easily. Code for all segmentation techniques are generated and applied on tumor containing images and then the plots are generated to accurately detect the contour of a tumour with respect to computational time.

Geetika Gupta, Rupinder Kaur et al, in their paper "Analysis and Comparison of Brain Tumor Detection and Extraction Techniques from MRI Images" have compared closely Edge detection, k means, and watershed algorithm. This paper has combined edge detection with k means clustering for colour-based detection using colour MRI images. For this purpose, an algorithm has been devised based on HSV colour model. The HSV model divides the image into 3 sections and then histogram, watershed, and edge detection techniques are applied. Upon finishing, all the 3 images are combined together to provide the result. K means clustering is combined with segmentation. Results show that k means is less complex and takes less time to execute.

Roopali R.Laddha and S.A.Ladhake in their paper "A Review on Brain Tumor Detection Using Segmentation And Threshold Operations" have proposed algorithm based on segmentation using morphological operators. They have also proposed a wavelet based algorithm which will make use of information provided by CT scan. The gray scale image is provided as the input image. Provided images undergo pre-processing stage (elimination of text and noise, sharpening of MRI image and enhancement), processing stage, post-processing stage (threshold segmentation and watershed transformation) and finally morphological operators are applied. This algorithm makes use of information given by CT scan or MRI images and then fuses the image to increase the effectiveness of tumour detection.

Ashwini A. Mandwe and Anisa Anjum in their paper "Detection of Brain Tumor Using K-Means Clustering" have worked upon k means segmentation technique. In this paper, noise-free MRI image will be provided as an input. The median filter is applied as a pre-processing. Next edges are identified using Sobel edge detection technique. Colour-based threshold technique is applied to locate the tumour exactly. Later. Segmentation technique is then applied and morphological operators are carried out.

III. Existing Methodology

1. **K means Clustering:**

K means algorithm is an unsupervised algorithm as it clusters the object based on provided criteria. K means clustering classifies a given data set through a certain number of clusters. It defines a K center for each cluster. Each cluster should be placed far away from each other as possible. Next step is to take each data set and associate it to the nearest center. When no point is pending, the first step is completed. Now, we re-calculate K new centroids. After we have K new Centroids, a new binding will be done. A loop has been generated. As a result of this loop, we will notice that K center change their location step by step until no more changes are undone.

ROUND 1:

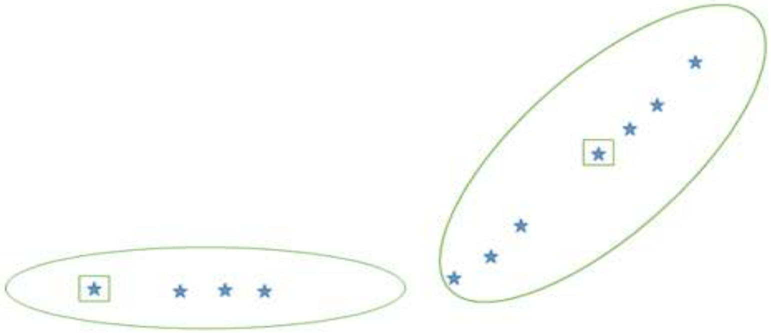


Fig 1. Cluster 1 and Cluster 2

ROUND 2: Computing new centroid

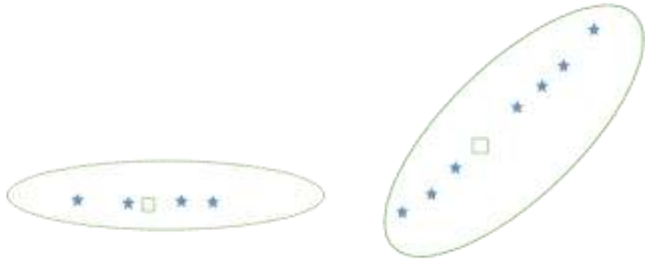


Fig 2: Cluster 1 and 2

ROUND 3: New centroid again

Fig 3: Cluster 1 and 2

SELECTION OF K:
Suppose we have the following datasets as shown below

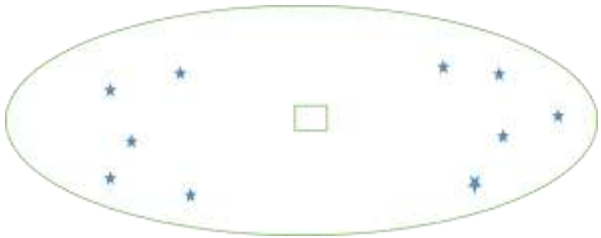


Fig 4: Selection of K in a cluster

An average distance is fairly large when K = 1. So if we have K = 2, we will split the cluster into two and the average distance will reduce significantly.

Fig 5: Cluster divided into two parts

If we increase K value further, suppose K=3, that does shrink the cluster but not as much when k = 3.

PICKING K INITIAL VALUE:

APPROACH 1st:

When data is large, we take a sample and make cluster, say 10 clusters and we pick a centroid in each cluster and call it as K, using hierarchical clustering.

APPROACH 2nd:

Select “dispersed” set of points:

a) Select the initial point randomly.
b) Select the second point far away from first point.
c) Same way, we will pick the third point far away from first and second. In general, we pick the point whose minimal distance from previous selected point should be large as possible.

Repeat until we have K points.

2**. WATERSHED:**

The objective of this algorithm is to detect watershed line which will result into segmentation of an image. Watershed segmentation envisions the grayscale image as a topological surface. In topography, the watershed is an edge that partitions the territory in waterway framework. Catchment bowl is the topographical region depleting into the river. Watershed transformation applies to grayscale images in such a way that it can solve image segmentation.

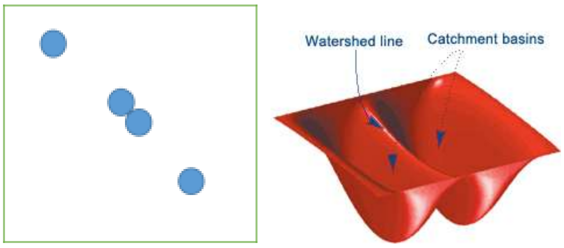


Fig 6: Grayscale image and catchment basin

If waterfalls on this, water will get accumulated in these 4 catchment basins. Rain falling on line between catchment basin, called watershed line will collect water in both the catchment basins with equal probability.

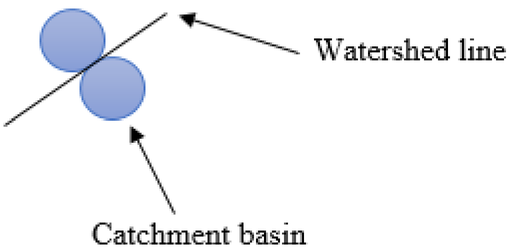


Fig 7: close look

After applying the watershed transformation to above image grayscale image, we obtain the following image. It did a great job in identifying the four different regions.

Fig 8: Transformed image

In watershed segmentation there are 3 distinct points:
a) The Point that belongs to the regional minimum.
b) Catchment basin of a regional minimum.
A Point at which drop of water will certainly fall to a single minimum.
c) Watershed Line.

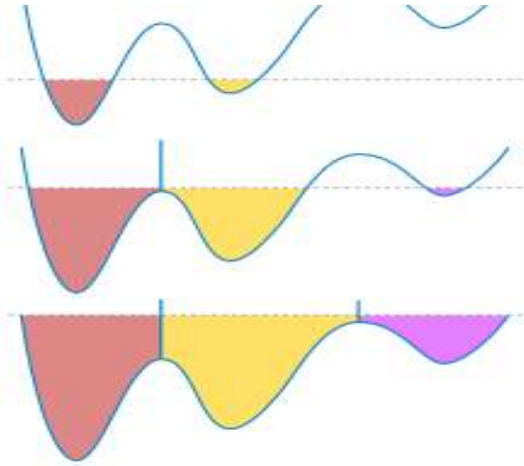


Fig 9

Suppose, we punch a hole at the bottom and the complete topography get flooded from below by letting the water level rise through holes at a constant rate. When water in different catchment basin is about to unite, we will create a line just like dam boundaries to prevent merging. These dam boundaries correspond to catchment basin. The only drawback of watershed segmentation is that it suffers from over-segmentation.

Solution for over segmentation
A Solution for over-segmentation is to use markers to specify the only allowed regional minima.
(a) Internal markers: Inside the object of the interest. It can be obtained by thresholding on gradient image.
(b) External Markers: These are contained in the background.

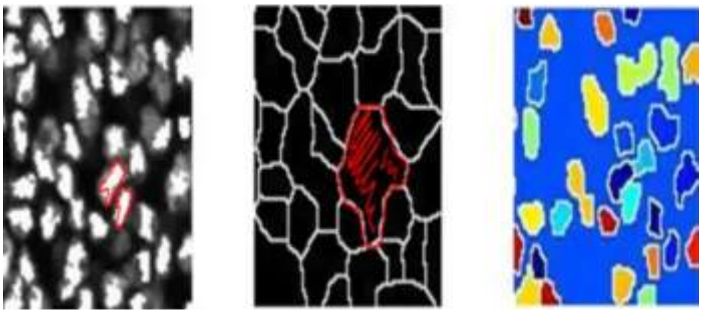
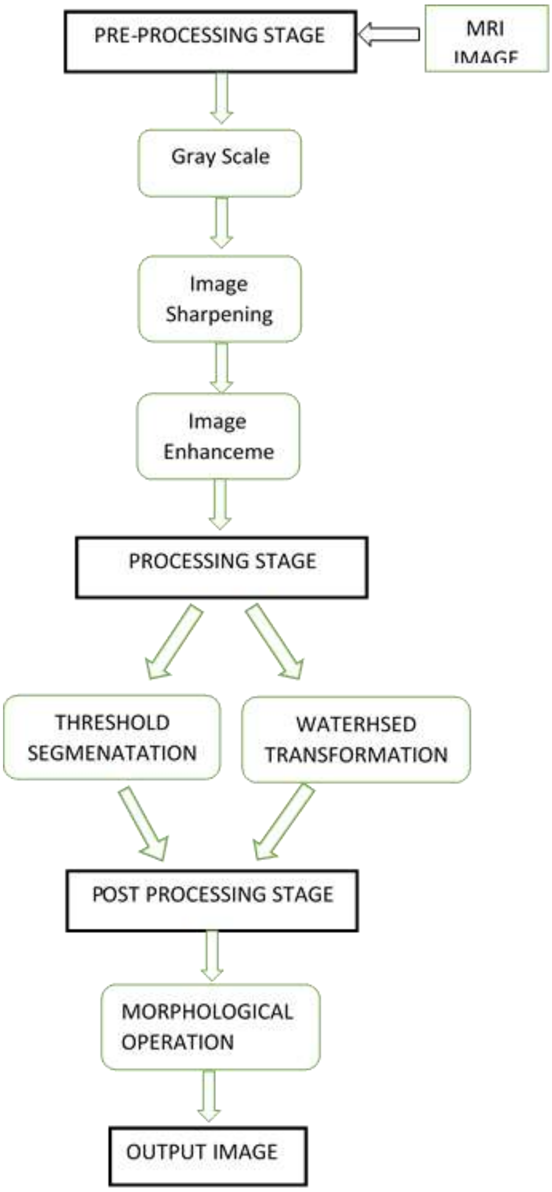


Fig 10: Internal Markers, External Markers, and watershed

IV. Experiment

We propose an algorithm for extraction of tumour from MRI scanned images using threshold and watershed transformation with the help of morphological operators. The experimental observations reveal that watershed algorithm is way better than Threshold segmentation. The execution steps of the proposed algorithm involve 3 stages: Pre-processing, processing, and processing stage. Pre-processing is for noise removal and image enhancement. Segmentation of tumour is processing stage. Post-processing involves morphological operators.



First of all, we need to include MRI images of a brain which consist of a tumour. Let say we have 2 images A and B for watershed and k means clustering respectively. These images, then need to be processed before segmentation. The need for image pre-processing is to detect edges cum sharpen the MRI image for more better and accurate results.

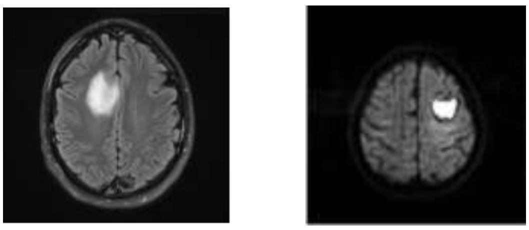


FIG 11: TUMOUR IMAGES

Once the pre-processing is completed, we can then apply segmentation technique (watershed and k means clustering). Here, we have applied threshold segmentation as shown below

Fig 12: Threshold image

The above image is so evident that one can easily see the tumour part highlighted as white part. This white part is primarily the zone with higher intensity value compared to a threshold value. Since we have the exact tumour area, we can now apply k means or watershed segmentation to above image and get the interested object as foreground.

Fig 13: Watershed and K means Clustering

Once, we have obtained the high-intensity values through watershed segmentation, we can then apply morphological operators such as Imerode, Imdilate. On the other hand, K means technique split the MRI image into 4 distinct parts – gray and white matter, CSF and background

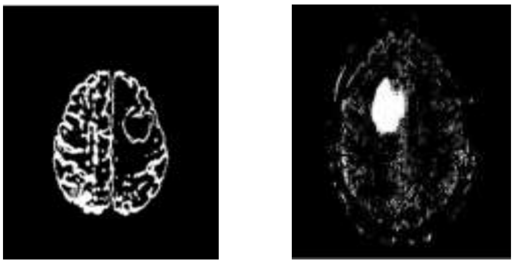


Fig 14 Morphological operations and K means – white matter

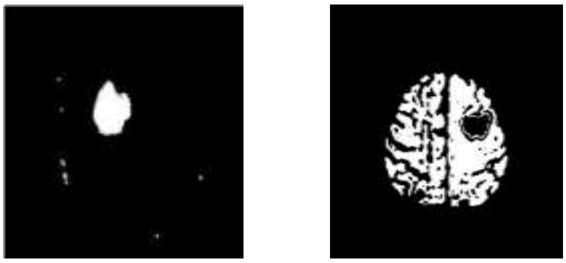


Fig 15: Imdialte and Cerebra spinal fluid

TUMOUR IS DETECTED AS WHITE PART:

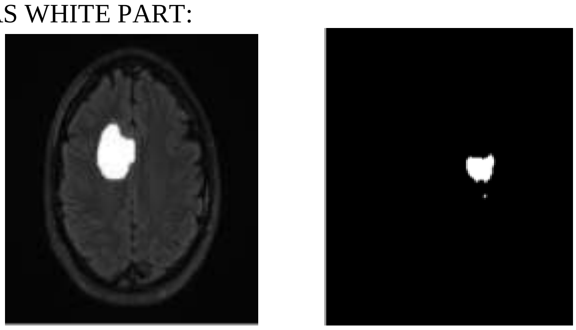


Fig 16 : Watershed and K means

V. Keypoints

Segmentation Techniques	Advantages	Disadvantages
Watershed	1) Helps to identify the regions clearly. 2) Based on morphological operators. 3) Easy to implement 4) Less execution time compared to K means clustering. 5) Marker- based watershed can be used to avoid over-segmentation.	1) Prone to over-segmentation
K Means Clustering	1) Robust in classification. 2) Intuitive technique of segmentation. 3) Cost efficient O(K*n*d) 4) Less complexity O(K*n) for n points in k clusters	1) Takes more time in execution compared to the watershed. 2) Works on assumption that all clusters are identical in nature. 3) Outlier sensitive

VI. Conclusion And Further Scope

In this comparative paper, we have analyzed watershed segmentation technique and k means clustering technique and discussed pros and cons of each. The objective behind comparison is to identify the best algorithm for tumour identification and detection. The predominant technique is segmentation which is done using k means and watershed along with morphological operators. Watershed technique is more efficient over K means in terms of Accuracy and time consumption. It provides 92% accurate results and takes 0.78 seconds to execute whereas turnaround time of K means clustering is 3.54 seconds. The K means algorithm can be further enhanced using various distance methods probably provide more accurate result over watershed in operational field.

References

[1]. Danyal Maheshwari, Ali Akber Shah,“ Extraction of Brain Tummour in MRI images using Marker Controlled Watershed Transform Technique in MATLAB ”, Journal of Biomedical Engineering and Medical Imaging, Volume 2, Issue 4, August 2015

[2]. Yogita sharma and Parminder Kaur, “Detection and Extraction of brain tumour using K-Means Clustering and watershed Algorithms”, International Journal of Computer Science Trends and Technology (IJCST) – Volume 3 Issue 2, Mar-Apr 2015

[3]. Rajesh C. Patil and AS Bhalachandra ,“Brain tumour extraction from MRI images using matlab ”, International Journal of Electronics, Communication & Soft Computing Science and Engineering ISSN: 2277-9477, Volume 2, Issue 1

[4]. Anam Mustaqeem, Ali javed and tehseen Fatima, “An efficient Brain tumour detection Algorithm using watershed and threshold based segmentation”, I.J. Image, Graphics and Signal Processing, 2012, 10, 34-39 Published Online September 2012

[5]. Neha Baraiya and Hardik Modi ,“Comparative Study of Diffferent Methods for Brain Tumour Extraction from MRI Images using Image Processing”, Indian Journal of Science and Technology, Vol 9(4), DOI:10.17485/ijst/2016/v9i4/85624, January 2016

[6]. V.Sagar Anil Kumar and T.Chandra Sekhar Rao, ”Brain Tumor Extraction by K-Means Clustering Based On Morphological Image Processing” , International Journal Of Engineering And Computer Science ISSN:2319-7242 Volume 3 Issue 10, October 2014 Page No. 8539-8546

[7]. Richa Aggarwal and Amanpreet kaur, “Comparative Analysis of Different Algorithms For Brain Tumor Detection”, International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Impact Factor (2012): 3.358

[8]. Geetika Gupta , Rupinder Kaur, “Analysis and Comparison of Brain Tumor Detection and Extraction Techniques from MRI Images”, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 11, November 2014

[9]. Roopali R.Laddha and S.A.Ladhake, “A Review on Brain Tumor Detection Using Segmentation And Threshold Operations”, (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (1), 2014, 607-611

[10]. Ashwini A. Mandwe and Anisa Anjum, “Detection of Brain Tumor Using K-Means Clustering”, International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064

IOSR Journal of Computer Engineering (IOSR-JCE) is UGC approved Journal with Sl. No. 5019, Journal no. 49102.

Garvit Pareek “Comparative Study of Watershed and K means Clustering in Brain Tumour Identification.” IOSR Journal of Computer Engineering (IOSR-JCE) , vol. 19, no. 5, 2017, pp. 42-50.