

# Brain Tumor Segmentation by Modified K-Mean with Morphological Operations

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**ABSTRACT:** This paper presents the scholars research on the implementation of segmentation algorithm for detection of range and shape of tumor in brain. Brain Tumor is an uncontrolled growth of tissues in any part of the body. Tumors are of completely different type of human disease and they have different characteristics and different treatment. As it is known brain tumor is inherently serious and life-threatening due to its character in the limited space of the intracranial cavity (space formed within the skull). Most research in developed countries show that the numbers of people who have brain tumors have died due to the actual fact of inaccurate detection. Generally, CT scan or MRI that is directed into intracranial cavity produces a whole image of brain. This image is visually examined by the physician for detection & identification of brain tumor. However this technique of detection resists the accurate determination of stage and size of tumor. To avoid that, this project uses 'modified k-mean with morphological operations'-a computer aided technique for segmentation (detection) of brain tumor based on the combination of two algorithms. This technique allows the segmentation of tumor tissue with accuracy and reproducible similar to manual segmentation. In addition, it also reduces the time for analysis. At the end of the process the tumor is extracted from the MRI images and its actual position and the shape also determined. The stage of the tumor is displayed based on the number of area calculated from the cluster.

In modified k-mean segmentation algorithm, optimize number of clusters are used. Generally morphological operation is used for object extraction and noise removal. Here it is used to enhance the object boundary and to remove the noise from the images. The addition of morphological operation added more accuracy in results. Here the affected areas have been calculated. To analyze the result for its accuracy, scholar has calculated the following parameters: Peak signal-to-noise ratio (PSNR), Mean squared error (MSE), Root-mean-square error (RMSE) and minimal execution time.

**KEYWORDS:** Brain Tumor, MRI, CT scan, Segmentation, Tumor Detection, K-mean, Morphology.

## I. INTRODUCTION

In today's life style, tumor, which is one of the most common brain diseases, has affected and ruined many lives. According to study of International Agency for research on Cancer (IARC), it is estimated that more than 126,000 people are diagnosed for brain tumor per year around the world and mortality rate is around 97,000 per year [1]. Normally the anatomy of the Brain is viewed with the help of MRI scan or CT scan. The brain tumor detection is a crucial vision application in the medical field. "A brain tumor is an abnormal growth of cells within the brain, which may be cancerous or non-cancerous (benign)". Brain tumor is one of the leading causes of death from cancer. There are two main types of brain cancer. They include primary brain cancer, during which the brain cancer originates in the brain itself. Primary brain cancer is the rare variety of brain cancer. Brain tumors can develop at any age, but are most common in children between the ages of 3-12, and in adults aged 55- 65. Secondary Brain cell spreads from other part of body and reaches brain cell to infect them, spreading of such type of cancer is called as metastasis.

**1.1 Brain tumors Imaging Techniques:** The anatomy of the brain is scanned by magnetic resonance Imaging (MRI) scan or computed tomography (CT) scan. The MRI scan is more comfortable than CT scan for diagnosis. It does not affect the body organs because it doesn't use any radiation. It is based on the magnetic field and radio waves [2].

(i) **MRI (Magnetic Resonance Imaging):** Magnetic resonance imaging (MRI) is a medical imaging technique, which utilized a non-invasive medical check in radiology to image the anatomy and therefore the physiological

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processes of the body in both health and disease. MRI scanners utilize strong magnetic fields, radio waves, and field gradients to form images of the body.

(ii) **CT Scan (Computed Tomography):** A CT Scan, also called X-ray computed tomography (X-ray CT) or computerized axial tomography scan (CAT scan) utilizes computer-processed combinations of many X-ray images taken from different angles to produce cross-sectional (tomographic) images of specific areas of a scanned object, allows the user to see inside the object without cutting.

## II. RELATED WORK

Medical image segmentation is considered as a one of the pioneer research topic one among many medical researchers. Several researchers have suggested different methodologies and algorithms for image segmentation. For example:

Eman Abdel-Maksoud, Mohammed Elmogy, and Rashid Al-Awadi introduced [3] an efficient image segmentation approach using K-means clustering technique integrated with Fuzzy C-means algorithm. It is followed by threshold and level set segmentation stages to provide accurate brain tumor detection. The proposed technique can get advantages of the K-means clustering for image segmentation within the aspects of least computation time. In addition, it can get advantages of the Fuzzy C-means in the aspects of accuracy. The performance of the proposed image segmentation approach was evaluated by comparing it with some state of the art segmentation algorithms in case of accuracy, processing time, and performance. The accuracy was evaluated by comparing the results with the ground truth of every processed image. The experimental results clarify the effectiveness of proposed approach to handle a higher range of segmentation problems via improving the segmentation quality and accuracy in minimal execution time. Siva Sankari S, Sindhu. M, Sangeetha. R, Shenbaga Rajan [4] in their research work the author proposed the concept for brain tumor segmentation and feature extraction. Normally the anatomy of the Brain is viewed by the MRI scan or CT scan. The MRI scanned image is taken for the entire process. The MRI scan is more comfortable than CT scan for diagnosis. It does not affect the human body. As a result of it doesn't use any radiation. However they will have some disadvantage in segmentation. In this research work, k-means algorithm is used for segmentation. So it provides the accurate result for tumor segmentation. The main aim of this research work is to extract optimal features to provide efficient result in feature extraction.

Roopali R. Laddha and S.A. Laddha [5] in their research work proposed an efficient wavelet based mostly formula for tumor detection that utilizes the complementary and redundant data from the computed tomography (CT) image and magnetic resonance Imaging (MRI) images. Thus this algorithm effectively uses the data provided by the CT image and MRI images there by providing a resultant consolidated image that will increase the efficiency of tumor detection. This research was conducted to observe brain tumor using medical imaging techniques. The main technique used was segmentation, which is done using a methodology based on threshold segmentation, watershed segmentation and morphological operators. The proposed segmentation method was experimented with MRI scanned images of human brains.

Islam and Ahmed [6] proposed image segmentation technique based on K-means, K-MediodS and hierarchical clustering technologies. They created a comparison between these three clustering techniques on natural images to find the benefits and drawbacks of each algorithm. When applying these algorithms, they mentioned that the K-means clustering technique has better performance and easy to implement than other clustering methods.

Jay Patel and Kaushal Doshi [7] during their analysis work; the authors planned numerous existing segmentation strategies for brain image are mentioned. During this analysis work numerous agglomeration strategies even have been used for segmentation for neoplasm detection in resonance imaging (MRI). MRI attributable to its give correct visualize of body structure of tissues during this analysis work a quick study of the assorted segmentation techniques for the MRI image segmentation area unit reviewed and discuss advantage and disadvantage regarding explicit strategies.

K. Padmavathi and C. Megala [8] in their research work authors proposed a technique of image process filtering and segmentation. It approaches the enhancements in filtering and segmentation performance that may be achieved by combining methods from distinct regions of the tumor image, a new image filtering and segmentation technique combining, region growing & detection of edges. The combination of this two technique helps to avoid characteristic segmentation errors and noise removal of an image that occurs once victimization region growing or edge detection singly. During this work, the brain image neoplasm testing method has been done. Pre-processing a picture

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provides the results of associate degree input image of neoplasm space. Segmentation and filtering method removes the noise over a picture and regain the ironed clear image of a neoplasm.

### III. PROPOSED METHODOLOGY

K-mean is utilized by medical image segmentation system which is capable of detecting tumor in brain. The k-mean algorithm is efficient and simple algorithm, which can run on high dimensional data set. Every coin has two sides, so k-mean has its own disadvantages. Sometimes it is unable to detect the tumor correctly, especially in case of malignant tumor.

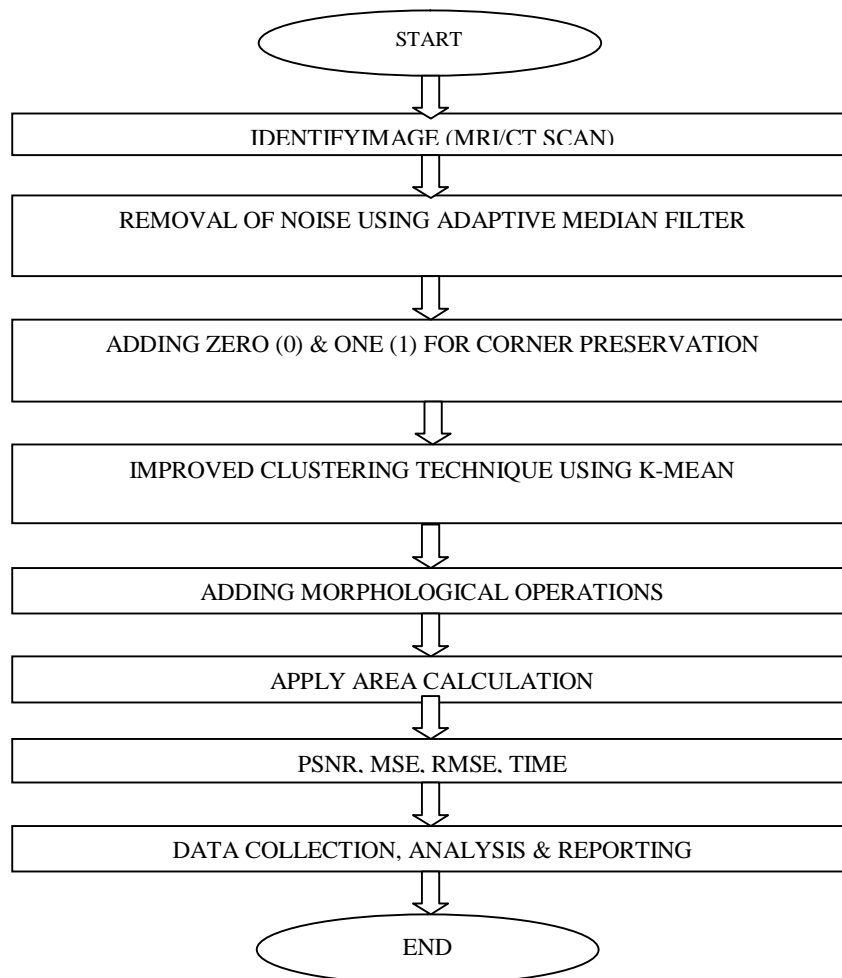


Figure1 Proposed Modified K-Means with Morphological operations image segmentation framework.

Signifying the disadvantage of k-mean, the given proposed work has been suggested it is shown in the figure 1 here step by step process has been illustrated. Proposed work is divided into total eight modules, they are connected in series that means output of one module act as input for another to achieve the desired goal of perfect image segmentation dataset consist of a lot of redundancy and noises, it is necessary to remove them before the actual work starts. In early stage of frame work preprocessing stage achieves de-noised image dataset. In later stages clustering is done for feature compression and the last module is dedicated for calculation used to find out the part of brain infected with brain tumor.

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Researcher has taken images (MRI or CT scan) from the standard Digital Imaging and Communications in Medicine (DICOM) data set after that adaptive median filter has been used to remove the noise. Adaptive median filter is used to remove corrupted pixels from the images [10]. Addition of extra 0 & 1 is done to preserve the corner points of image. This addition do not adds any extra result. Modified k-mean is used for the clustering techniques. Clustering technique is nothing but dividing whole images in small number of groups and putting the corresponding pixels to a particular group. To apply k-mean number of cluster in image should be known.

Time taken to simulate each algorithm was recorded and it was found that k-means clustering algorithm was fastest followed by all other segmentation methods. Also, the results show that all the other segmentation method segmented only tumor cell while the clustering algorithm suffered with false detection problem. The false detection problem can be removed by the modified k-means with adding morphology operations [11].

## IV. EXPERIMENTAL SETUP

### 4.1 DATA SET

In order to see the performance of image segmentation approach used (DICOM) standard data sets [12]. DICOM consists of 22 images that contain brain tumor. All DICOM image files are encoded in JPEG2000 transfer syntax with “.DCM” extension. It has no ground truth images for the contained images. It contains simulated brain MRI data based on two anatomical models: normal and multiple sclerosis (MS).

### 4.2 Results and Discussion

In this section, the results of proposed image segmentation technique that have been obtained using real MRI brain images from Digital Imaging and Communications in Medicine (DICOM) data set. This work was implemented using MATLAB 7.12.0 (R2012b). The experiments are done on a core i5/2.4 GHz computer with 8 GB RAM and an NVIDIA (1 GB VRAM) VGA card. There are 22 images in the digital imaging and communications (DICOM) dataset. The comparison was been done between the five tested techniques i.e. k-means (KM), Expectation maximization (EM), Fuzzy C-mean (FCM), K-means integrating with fuzzy C-mean (KIFCM), Modified k-mean with morphology (MKM) according to the following performance measures accuracy, precision and recall etc.(Formula 1 to 7).Each of them is separately explained below:

True Positive:

$$TP = \frac{\text{Number of Resultant Images having Brain tumor}}{\text{Total number of images}} \quad (1)$$

True Negative:

$$TN = \frac{\text{Number of resultant images doesn't brain tumor}}{\text{Total number of images}} \quad (2)$$

False Positive:

$$FP = \frac{\text{Number of images haven't tumor detected positive}}{\text{Total number of images}} \quad (3)$$

False Negative:

$$FN = \frac{\text{Number of images have tumor & not detected}}{\text{Total number of images}} \quad (4)$$

Accuracy:

$$\text{Accuracy} = \left[ \frac{(TP + TN)}{(TP + TN + FP + FN)} \right] \quad (5)$$

Precision:

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$$Precision = \left[ \frac{TP}{TP + FP} \right] \tag{6}$$

Recall:

$$Recall = \left[ \frac{TP}{(TP + FN)} \right] \tag{7}$$

Table 1: Performance Parameters and its Value for KM, EM, FCM, KIFCM, MKM Algorithms

METHODS	PERFORMANCE PARAMETERS AND ITS VALUE						
	TP	TN	FP	FN	Accuracy	precision	Recall
<b>KM</b>	85.7	0	0	14.3	85.7%	100%	85.7%
<b>EM</b>	66.6	0	0	33.4	66.6%	100%	66.6%
<b>FCM</b>	85.7	0	0	14.3	85.7%	100%	85.7%
<b>KIFCM</b>	90.5	0	0	9.5	90.5%	100%	90.5%
<b>MKM</b>	95.5	0	0	4.5	95.5%	100%	95.5%

Above Table 1 show the performance comparison between the given five tested techniques has been achieved after processing entire row of each column. Here we can see there are 7 parameters: True positive (TP), True negative (TN), False positive (FP), False negative (FN), accuracy, precision, and recall) each of them illustrates about values obtained from different algorithm.

Table: 2 Comparative Execution times of KM, EM, FCM, KIFCM, MKM Algorithms for given dataset

IMAGES	KM	EM	FCM	KIFCM	MKM
1	7.52	34.47	59.52	12.87	2.87
2	1.76	8	15.92	5.18	2.98
3	4.34	32.06	6.89	3.46	3.23
4	7.52	34.47	59.52	12.87	2.87
5	1.76	8	15.92	5.18	2.98
6	4.34	32.06	6.89	3.46	3.23
7	7.52	34.47	59.52	12.87	2.87
8	1.76	8	15.92	5.18	2.98
9	4.34	32.06	6.89	3.46	3.23
10	7.52	34.47	59.52	12.87	2.87
11	1.76	8	15.92	5.18	2.98
12	4.34	32.06	6.89	3.46	3.23
13	7.52	34.47	59.52	12.87	2.87
14	1.76	8	15.92	5.18	2.98

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IMAGES	KM	EM	FCM	KIFCM	MKM
15	4.34	32.06	6.89	3.46	3.23
16	1.76	8	15.92	5.18	2.98
17	7.52	34.47	59.52	12.87	2.87
18	1.76	8	15.92	5.18	2.98
19	4.34	32.06	6.89	3.46	3.23
20	7.52	34.47	59.52	12.87	2.87
21	1.76	8	15.92	5.18	2.98
22	7.52	34.47	59.52	12.87	2.92

Table 2 shows the execution time for the tested above five techniques for the given dataset. It consists of 22 rows it has information about 22 images where each column identifies execution time taken by each method like k-means (KM), Expectation Maximization (EM), fuzzy c-mean (FCM), k-means integrated with fuzzy c-mean (KIFCM) and modified k-mean with morphology (MKM). Table 2 clearly shows superiority of proposed method over other if execution time for detecting tumor is concerned. In table 2, each column represents execution time of single image for detecting tumor. Dataset described in table is feed to following algorithms like KM, EM, FCM, KIFCM and MKM, to obtain the given dataset with the following attributes (TP, TN, FP, FN, Accuracy, Precision, and Recall).

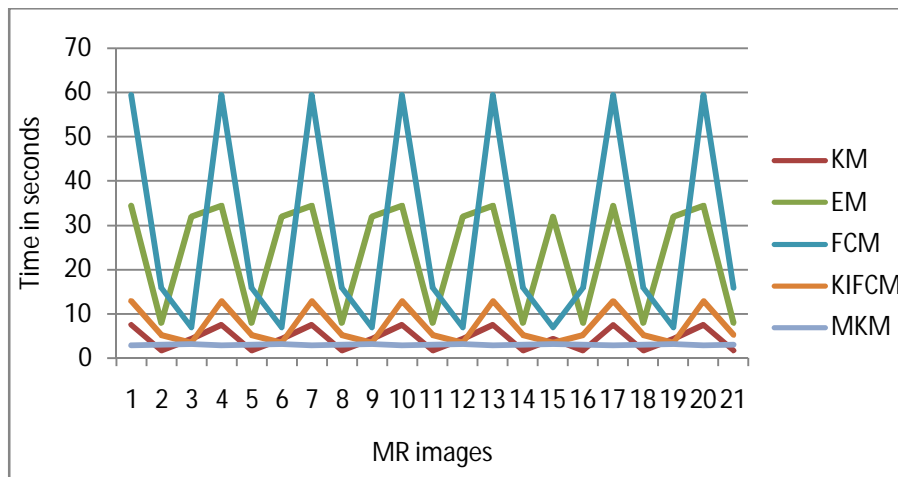


Figure 2 Comparative Execution Time Graph for KM, EM, FCM, KIFCM, and MKM Algorithms on DICOM Data set

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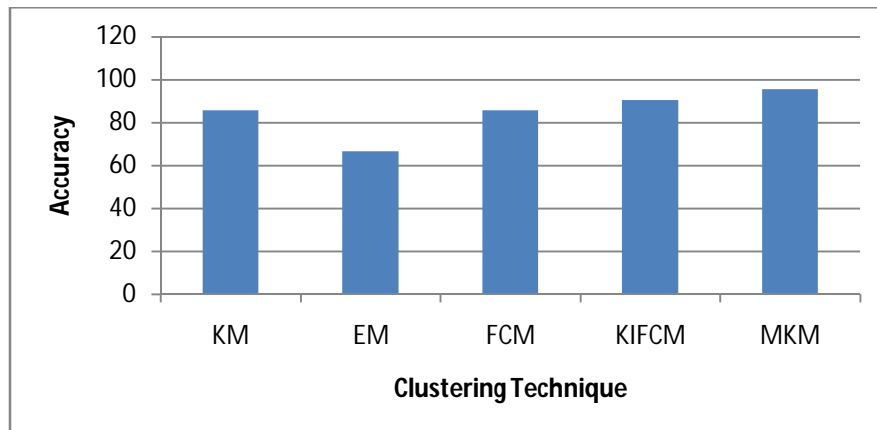


Figure 3 Comparative Accuracy Graph for KM, EM, FCM, KIFCM, MKM Algorithms on DICOM Dataset.

Above Figure 2 shows the comparative execution time for the tested five techniques for DICOM dataset and figure 3 shows that the comparative accuracy diagram of the five tested techniques. Above figure 3 illustrates about accuracy achieved from different clustering techniques. This clearly shows the importance of proposed modified k-mean with morphology (MKM) method where accuracy is 95.5% which is better than all other compared algorithms of clustering. Finally, the scholar has got improved results; when compared with earlier methods like k-means (KM), Expectation Maximization (EM), fuzzy c-mean (FCM), k-means integrated with fuzzy c-mean (KIFCM) and modified k-mean with morphology (MKM) for the given dataset. As shown in table the proposed method giving improved result. The graph has been shown which also showing the improved result of the proposed method.

## V. CONCLUSION AND FUTURE WORK

This method modified K-mean with morphology (MKM) shows the better result by comparing with other four methods like KM, EM, FCM & KIFCM. The proposed method shows accurate result of area calculation of tumor due to morphological based area calculation method. Accurate area calculation is the major part of the proposed work. In this proposed method try to remove the drawback of previous method. Previous methods are not calculating the accurate area of the tumor.

In future, focus on different types of tumor detection in other body part like Lung, stomach and other parts of body can be taken up. Improvement in accuracy and algorithm complexity in tumor detection can be done. In future the implementation of the proposed method in 3D image can also be taken up and the volume of the tumor can be calculated.

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