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Combining clustering methods for tumor diagnosis in brain MRI images An improved tumor identification method using hybrid clustering algorithms

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Abstract— **A tumor is a mass of tissue formed by the accumulation of abnormal cells. It is very important to detect the tumor in its early stages. This paper proposes a framework for the detection of brain tumor efficiently which mainly consists of four stages: image selection, pre-processing, segmentation and tumor detection. Image segmentation plays a significant role in medical diagnosis. A new approach is developed to implement segmentation that integrates K-means and Fuzzy C-means clustering algorithm.**

Keywords— Brain tumor segmentation; Median filter; KIFCM algorithm; Magnetic Resonance Imaging

I. Introduction

Brain tumor detection in magnetic resonance imaging (MRI) has become an emerging field of medical image analysis. Medical imaging refers to several different technologies that are used to diagnose, monitor, or treat medical conditions. MRI is commonly used in the medical field for detection and visualization of details of internal structure of the body. The anatomy of the brain can be captured using Magnetic Resonance Imaging (MRI) scan or computed tomography (CT) scan. MRI scan is found to be better than CT scan for diagnosis since it does not use radiation. Early detection of cancerous tissues plays a significant role on improving the survival rate of the patients [1]. Thus, there is a need for an efficient medical image segmentation method with some preferred properties such as minimum user interaction, fast computation, accurate, and robust segmentation results [2].

Segmentation of images is one of the most difficult tasks that hold an important position in image processing. It is the process of partitioning an image into mutually exclusive regions. It assigns a label to every pixel in an image such that pixels belonging to the same label share common characteristics. There are several algorithms developed for the same. Still, it remains challenging due to image noise and other such factors. Since segmentation plays a significant role in medical image processing, it is essential to develop an efficient technique for segmentation in terms of accuracy and computation time.

There are various general-purpose algorithms and techniques for image segmentation. Image segmentation algorithms are based on discontinuity or similarity [3]. The segmentation approach is by partitioning the processed image based on changes in intensity, such as edges and corners. Another method is to partition the image into similar regions that are similar due to a set of predefined criteria. Therefore, there are many segmentation techniques which can be broadly used, such as histogram based methods, edge-based methods, artificial neural network based segmentation methods, physical model based approaches, region-based methods and clustering methods (Fuzzy C-means clustering, K-means clustering, Mean Shift, and Expectation Maximization) [4–6].

In this paper, a new approach is developed to detect the tumor by integrating K-means and Fuzzy C-means clustering algorithm. By integrating these two algorithms, we get the benefits of improving the execution time and obtaining an accurate result of tumor detection, by reducing the number of iterations.

There are four steps involved in the proposed framework which includes image selection, pre-processing, segmentation and detection. The image selection process selects the desired image file with proper extension. In pre-processing, the noise is removed from the selected image. This is followed by segmentation of the pre-processed image which segments the image into different clusters. Finally tumor is detected if present in the MRI image in the detection stage

II. RELATED WORKS

Bandhyopadhyay and Paul [7] proposed segmentation method based on K-means clustering technique. It consists of three steps: K-means algorithm based segmentation, local standard deviation guided grid based coarse grain localization, and local standard deviation guided grid based fine grain localization. It involves clustering the MRI image into two classes. The first class consists of normal brain cells whereas the second class consists of brain tumor cells. The segmentation procedure is constrained by the fact that the images should be of adjacent imaging layer. It also ignored finer details of the brain.

Glavan and Holban [8] proposed a convolution neural network (CNN) as a pixel classifier for the segmentation of some X-ray images. The system analyses each pixel from the image and tries to classify them into two classes: bone and non-bone. Problems were observed when the bone areas were presented with irregularities.

Tatiraju and Mehta [9] introduced image segmentation using K-means clustering, Expectation Maximization (EM), and Normalized Cuts (NC). They analysed the first two unsupervised learning algorithms and compared them with a graph-based algorithm, the Normalized Cut algorithm. It was observed that for smaller values of k Expectation Maximization gave good results whereas for larger values of k segmentation became coarse. Normalise Cuts algorithm took longer execution time.

Funmilola et al. [10] made the Fuzzy K-C-means method, which carries more of Fuzzy C- means properties than that of K-means. The results of Fuzzy K-C-means segmentation algorithm were observed to be similar to Fuzzy C-means algorithm.

Wilson and Dhas [11] used K-means and Fuzzy C-means respectively to detect the iron in brain SWI. The extraction of the iron region in the brain is made by K-means and Fuzzy C-means clustering method. The extraction of the iron region in the brain is made by K-means and Fuzzy C-means clustering method. The SWI is compared for brain iron using K-means and FCM methods. The tests done on Fuzzy C-means indicates that the iron regions are easily visible than the output of K-means image. The main disadvantage was that they did not make an attempt to integrate both methods to overcome the disadvantage of both methods.

III PROPOSED DETECTION SYSTEM

Computer vision is a widely used for medical image processing, particularly for identification of tumors in various types of medical imagery. There are several detection systems available. Most of the systems either use K-means clustering algorithm or Fuzzy C-means clustering algorithms. The systems based on K-means suffer from incomplete detection of tumor whereas the system based on Fuzzy C-means is affected by noise, outliers and other such factors. There are various performance evalution metrics such as peak signal-to-noise ratio (PSNR), mean squared error (MSE), correlation coefficient (CC), etc. Fig.1 shows the basic framework of the proposed system.

A. IMAGE SELECTION

The medical image processing deals with a variety of images such as MRI, CT etc for the diagnosis of medical conditions.In the proposed system MRI image is used for tumor detection.The image selection stage selects the MRI image with proper dimension as input. This selected image is further pre-processedfor processing.

B. PREPROCESSING

Digital images may be susceptible to variety of noise. Noise occurs mainly due to error in instrument or during the image acquisition process. The intensity of pixels may vary from the actual pixel intensity

C. SEGMENTATION

Image segmentation is the process of segmenting or partitioning an image into similar regions. Segmentation aims at making an image more meaningful and easier to analyze. Here in segmentation KIFCM algorithm is used. K-means clustering is an algorithm used for cluster analysis in data mining. It partitions observations into k clusters. Each observation belongs to the cluster with the nearest mean. This results in a partitioning of the data space into tumor cells.

In fuzzy clustering, rather than belonging completely to just one cluster, every point belongs to a cluster with a certain probability. Thus, points on the edge of a cluster may be in the cluster to a lesser degree than points in the centre of clustering. In KIFCM algorithm centroids calculated using K-means and Fuzzy C-means algorithm are compared with each other and the differences between them is analyzed. If the difference is small then the centroid calculated using K-means algorithm is chosen for consideration. Else the centroid calculated using Fuzzy C-means algorithm is chosen. Thus by using KIFCM algorithm it gets the benefits of K-means clustering for image segmentation in the aspects of minimal computational time. Also, it gets the advantage of Fuzzy C-means clustering in terms of efficiency and accuracy. Thus the proposed syste

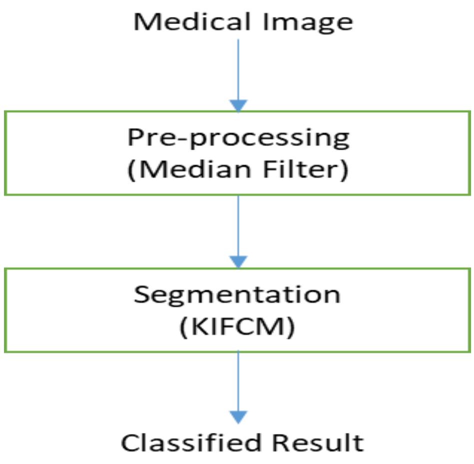


Fig1.Flow chart for tumor Detection

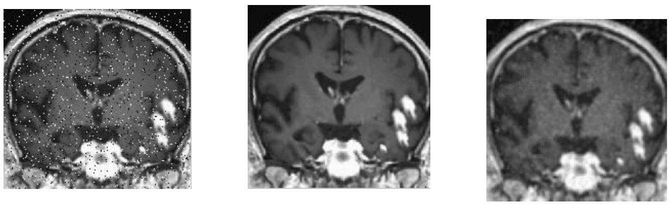
The different types of noise that is present in the image should be removed for processing. This phase is implemented by applying a specified filter in order to remove the noise present in the selected image before further processing. Brain images should be free of noise and should be of high quality. So, inorder to perform the denoising of the selected input image, median filter is applied in the proposed system. Median filtering is a nonlinear filter that is used as an effective method for removing noise while preserving edges. It replaces each pixel with the median of neighboring pixels. We can use sliding window or non-overlapping windows. The median is calculated by first sorting the pixel values from the window, and then replacing the pixel being considered with the middle (median) pixel value.

The advantages of using median filter is that it does not shift boundaries, as can happen with conventional smoothing filters a contrast dependent problem. Median is less sensitive than the mean to outliers which are the extreme values that can be effectively removed.

	Median Filter			Averaging Filter		
	Img1	Img2	Img3	Img1	Img2	Img3
PSNR	21.79	21.85	22.16	11.99	11.75	12.28
MSE	433.35	427.83	398.48	4135.18	4376.18	3873.12

Fig.2. Comparison between median filter and average filter by using three images.

Fig.2. shows the performance of median filter and average filter. Based on the image analysis median filter outperforms ten times the averaging filter on MSE (Mean Squared Error) value. On the basis of PSNR (Peak Signal to Noise Ratio) value median filter outperforms two times the averaging filter.



(a) (b) (c)

Fig.3. Comparison between median filter and average filter for noise removal. (a)Noised image (b) Median filter (c) Average filter

D. TUMOR DETECTION

In the next stage tumor if present needs to be identified. The MRI image is analyzed with a number of other images that consist of tumor. The image that matches with the selected image is found out and the tumor is detected. Detection of brain tumor through MRI can provide the valuable outlook and accuracy when compared to earlier brain tumor detection methods.

IV CONCLUSION

In this paper Image segmentation plays a significant role in medical image. MRI is the most effectively ima+HGEge model used for diagnostic image examination for brain tumour. Brain tumor is diagnosed at advanced stages with the help of the MRI image.The MRI scan is more comfortable than CT scan for diagnosis. Therefore, we developed a new approach that integrates the K-means clustering algorithm with the Fuzzy C- means algorithm to detect brain tumour accurately and in minimal execution time. Our framework consists of four stages: Image Selection, pre-processing (Median Filter), Segmentation (integration of K-means and Fuzzy C-means), and Tumour detection. From the experimental results, we proved the effectiveness of median filter is better than averaging filter. Our proposed system determines the initial cluster k value to minimize the execution time. The performance of the proposed technique, its minimization time strategy, and its quality has been demonstrated in several experiments. As well as to increase the efficiency of the segmentation process, an intensity adjustment process will provide more challenging and may allow us to refine our segmentation techniques to the MRI brain tumor segmentation.

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