Lecture 7
Fourth stage

Medical Imaging Processing II

Image Segmentation using clustering

By

Asst. Prof. Dr. Mehdi Ebady Manaa
Asst. Lect. Lubna ali jalil

Clustering techniques are image segmentation methods by which individual elements are placed into groups. Some of these other domains include color space, histogram spaces, or complex features spaces. Recursive region splitting is a clustering method that has become a standard technique. This method has become a standard technique (this method uses a thresholding of histogram techniques to segment the image). This algorithm proceeds as follows:

1. Consider the entire image as one region and compute histograms for each component of interest (for example, red, green, and blue for color image).

2. Apply a peak finding test to each histogram. Select the best peak and put thresholds on either side of the peak. Segment the image into two regions based on this peak

3. Smooth the binary threshold image so that only a single connected sub region is left. 4. Repeat steps 1–3 for each region until no new sub regions can be created that is no histogram have significant peak.

Methods of Medical image clustering

Image segmentation is an important process for most medical image analysis tasks. Having good segmentations will benefit clinicians and patients as they provide important information for 3-D visualization, surgical planning and early disease detection.

There has also been an increasing interest in applying soft segmentation algorithms, where a pixel may be classified partially into multiple classes, for MR images segmentation. ***The fuzzy C-means clustering algorithm (FCM)*** is a soft segmentation method that has been used extensively for segmentation of MR images. However, its main disadvantages include its computational complexity and the fact that the performance degrades significantly with increased noise. **K-means clustering algorithm** on the other hand, is a simple clustering method with low computational complexity as compared to FCM. The clusters produced by K-means clustering do not overlap. K-means clustering is produced a primary segmentation of the image

A magnetic resonance imaging (MRI) scanner uses powerful magnets to polarise and excite hydrogen nuclei (single proton) in human tissue, which produces a signal that can be detected and it is encoded spatially, resulting in images of the body. The MRI machine emits radio frequency (RF) pulse that specifically binds only to hydrogen. The system sends the pulse to that specific area of the body that needs to be examined. Due to the RF pulse, protons in that area absorb the energy needed to make them spin in a different direction. This is meant by the resonance of MRI. The RF pulse makes the protons spin at the larmour frequency, in a specific direction. This frequency is found based on the particular tissue being imaged and the strength of the main magnetic field. MRI uses three electromagnetic fields: static field which is a very strong static magnetic field which polarizes the hydrogen nuclei; gradient field which is a weaker time varying field used for spatial encoding; and a weak radio frequency field for manipulation of the hydrogen nuclei to produce measurable signals, which are collected through radio frequency antenna.

The Challenges in medical image segmentation

The brain is the anterior most part of the central nervous system. Brain tumour is an intracranial solid neoplasm. Tumours are created by an abnormal and uncontrolled cell

division in the brain. It was used axial view of the brain image (2D) from MRI scan because MRI scan is less harmful than CT brain scan. A patient is subjected to different

diagnostic methods to determine the cause of the symptoms mentioned by him. Techniques like performing a biopsy, performing imaging, like taking a MRI or CT scan of the brain will be done. In biopsy, pathologists take a specimen of the brain tissue under consideration for checking the presence of tumour. A pathologist looks at the tissue cells under a microscope to check for presence of abnormality. Though biopsy will show the presence of tumour and its pathology, when doctors go for surgery, they must know the tumour extent and the exact location of tumour in the brain, which can be found by taking MRI scan of the patient as MRI doesn't involve the use of harmful radiations when compared to CT scan. *Traditional method in hospitals is to segment the medical image under consideration, manually and this depends on how* *well the physician can perceive the image under consideration to get the required region extracted out, which is made difficult because of minute variations and resemblance between the original and affected biological part in the image. The shortage of radiologists and the large volume of MRI to be analyzed make these readings labor intensive and also cost expensive.*

K-means clustering method

K-means clustering algorithm, which is an unsupervised method, provides us with a primary segmentation of the image. we observed that there are many regions with similar intensities in a MR image of the head, which result in many local minima that increases over segmentation, K-means clustering is used because it is simple and has relatively low computational complexity.

K-means is one of the simplest unsupervised learning algorithms that solve the well known clustering problem. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters fixed a priori. This algorithm aims at minimizing an objective function, in this case a squared error function.

In addition, it is suitable for biomedical image segmentation as the number of clusters (K) is usually known for images of particular regions of human anatomy. MR image of the head generally consists of regions representing the bone, soft tissue, fat and background. This is an iterative technique that is used to portion an Image into clusters. In the clustering method number of clusters K is an input parameter. The main challenge is also the same, because quality of the segmented output depends on the K. Procedure for the k-means clustering is.

1. **Pick K cluster centers, either randomly or based on Some heuristic**
2. **Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the Cluster center.**
3. **Re-compute the cluster centers by averaging all of the pixels in the cluster.**
4. **Repeat steps 2 and 3 until convergence is attained (E.g. no pixels change clusters).**

Clusters can be selected manual y, randomly, or based on Some conditions. Distance between the pixel and cluster center is calculated by the squared or absolute difference between n a pixel and a cluster center.

Case 1; brain tumor segmentation using k-means

The general step of the k means segmentation is shown in figure (1)

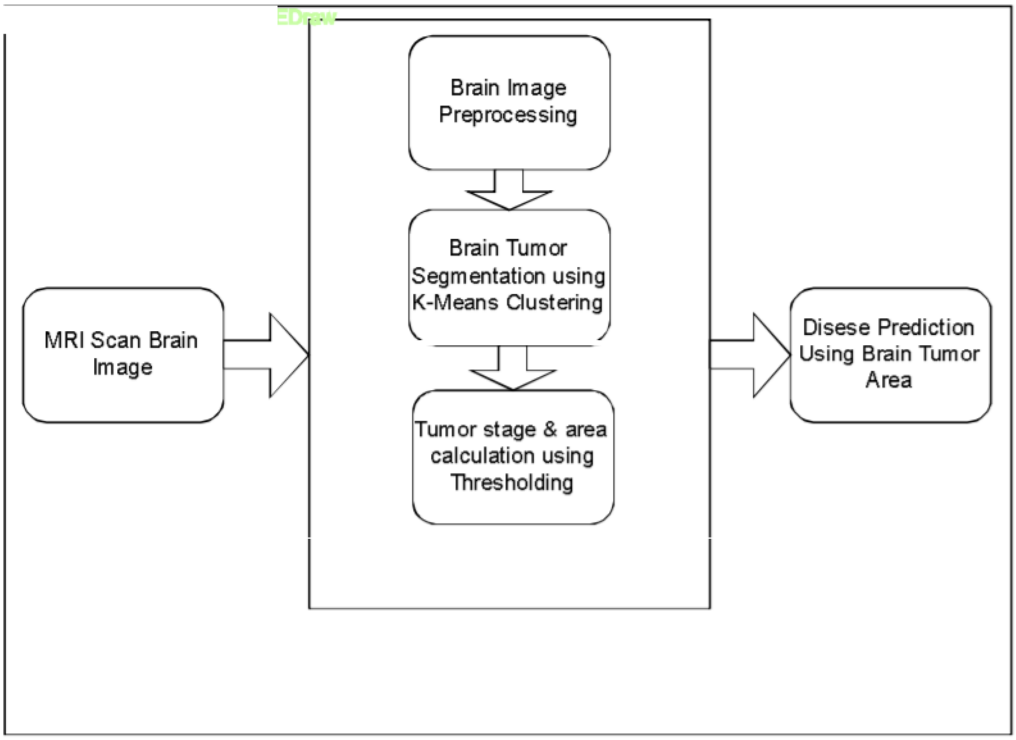
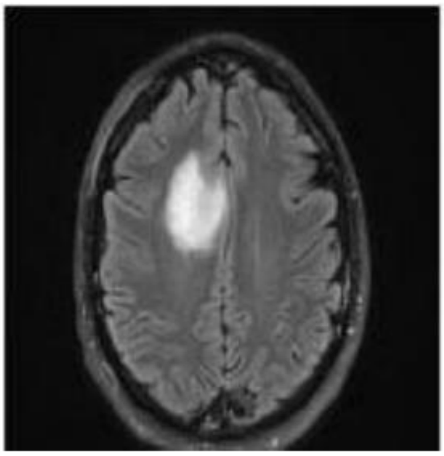


Figure 1: the general step of segmentation

Let us consider the brain tumor image procured from MRI, containing the tumor in figure 2. Median filtering is implemented on the acquired images to get rid of the unwanted noises. The outcomes are displayed in the figure 3.



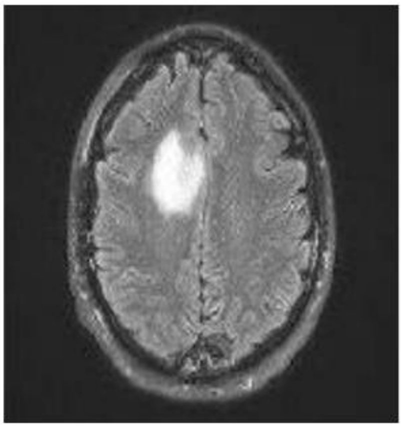


Figure 2: brain tumor image figure 3: Median Filtering Outcome

K means algorithm is implemented on such noise filtered images containing brain tumors. In figure 4, a white spot is seen, which is an outcome of the application of threshold segmentation on the input image. This region is the area having higher intensity values compared to the defined threshold. Areas with higher intensity values mostly contains ulcer. The outcomes of thresholding segmentation are shown below in figure 4.

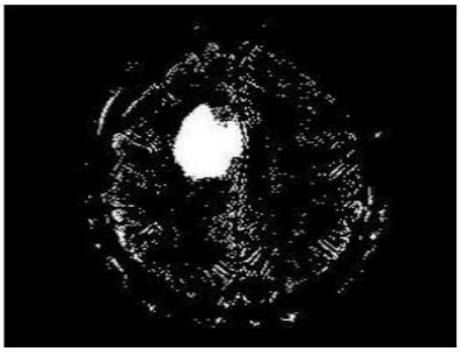


Fig. 4 K Means Clustering

Initial cluster centers are chosen in a first pass of the data. The dataset is partitioned into K clusters and the data points are randomly assigned to the clusters resulting in clusters that have roughly the same number of data points. For each data point, we calculate the Euclidean distance from the data point to the mean of each cluster. If the data point is not closest to its own cluster, it will have to be shifted into the closest cluster. If the data point is already closest to its own cluster, we will not shift it. The process continues until cluster means do not shift more than a given cut-off value or the iteration limit is reached. The result of the MR image in Figure 5(a), after K-means clustering, is shown in Figure 5(b).

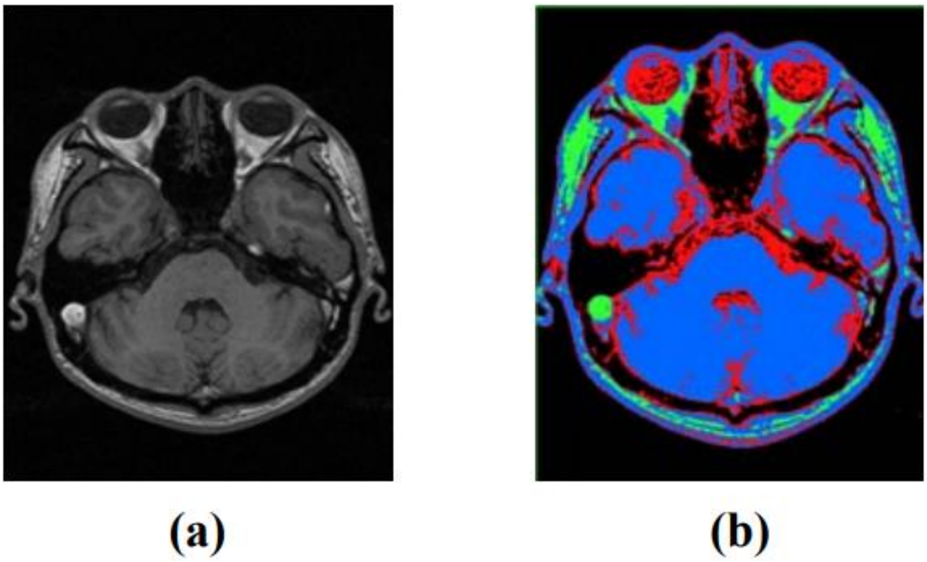


Figure 5. (a) MR image (b) MR image after K-means clustering