K – Means Clustering Algorithm for Brain Tumor Segmentation

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***Abstract*-** Brain tumor is an abnormal and uncontrollable growth of cells inside the brain. The identification of a tumor in the brain is a challenge due to the complications in the structure of the brain. We can identify brain tumors with the help of these MR Images collected as Big Data. From these MR Images, we are able to determine the detailed anatomical information to examine the development of the human brain and to diagnose the various diseases. The detection of brain tumor becomes most complicated for the huge image database. So an algorithm approach is required to help the accurate and faster clinical diagnosis. This paper is mainly focuses on a brain segmentation of MR Images by K - Means Clustering Algorithm to diagnose accurately the region of Brain Tumor. After the segmentation, which is through K-Means Clustering Algorithm the brain tumor is detected.

***Index Terms*=** Brain Tumor, Magnetic Resonance Imaging (MRI), K-Means Clustering Algorithm, Segmentation and Detection.

I. INTRODUCTION

A brain tumor is a mass, or lump in the brain which is caused when brain cells divide and grow in an uncontrolled way. The cells in our body grow, divide and multiply to help with our body's natural processes, such as damage repair, and to replace old cells. But, sometimes mistakes can be made during cell growth and division. And abnormal cells are formed.

Usually, the body's natural defense mechanisms destroy these abnormal cells, but occasionally the abnormal cells grow, multiply and form a lump of cells. This is called a tumor. When this happens in the brain, a primary brain tumor is formed. There are more than 100 billion nerves present in the human brain that are in an overlapped form. So the diagnosis of the tumor area in the brain is a challenging task [1].

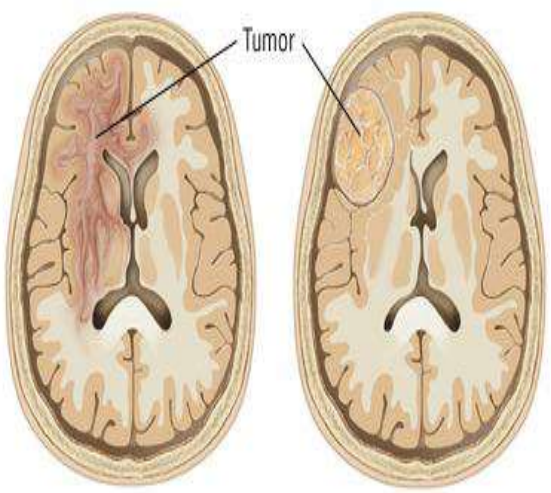
Brain tumor symptoms can develop in people of all ages – including teens. In recent years, nearly 13% of all new brain cancers were diagnosed in patients under the age of 20, and another 9% were diagnosed in patients between the ages of 20 and 34. The tumor is due to the uncontrollable growth of cells in the brain. Two types of primary brain tumors that are benign tumor and malignant tumor. A Brain tumor is small in size, grows slowly and it has well-defined borders. It does not spread in the spinal cord, other parts of the brain or other areas of the body and it can be removed completely by surgery. The malignant type of tumor is fast-growing, affects healthy brain cells and may spread to other parts of the brain or spinal cord. It is harmful and may remain untreated.

A. Types of Brain Tumors

Brain tumors are divided into two main types:

1) Benign Tumors: Benign brain tumors not contain cancer cells. The benign tumors can be easily removed and it rarely grows back. Benign tumor cells do not infect surrounding tissues or transmit in other body parts. These tumors can cause serious problems by suppressing the sensitive areas of brain. Very rarely, they are life threatening and become malignant [2], as shown in Fig.1 (b).

2) Malignant Tumors: Malignant brain tumors are more serious than benign tumor as they are life threatening. It can be primary or secondary type of tumor, originating from brain tissue or metastasis from other tumor in the body at any other place. They can grow rapidly and affect nearby healthy brain tissues. Very rarely, cancer cells may break away from malignant brain tumor and spread to other parts of the body [2] as shown in Fig.1 (a).



(a) Malignant **(b) Benign**

B. Magnetic Resonance Imaging

An MRI scan uses a large magnet, radio waves, and a computer to create a detailed, cross-sectional image of internal organs of a human body. The scanner itself typically resembles a large tube in the middle, allowing the patient to slide in. MRI scan differs from CT scans and X-rays, as it does not use potentially harmful ionizing radiation [3].

II. Uses of MRI

The development of MRI scan represents a huge milestone for the medical world. Doctors, scientists, and also researchers are now able to examine the inside of the human body in high detail using a non-invasive tool. The following are examples are in which an MRI scanner would be used:

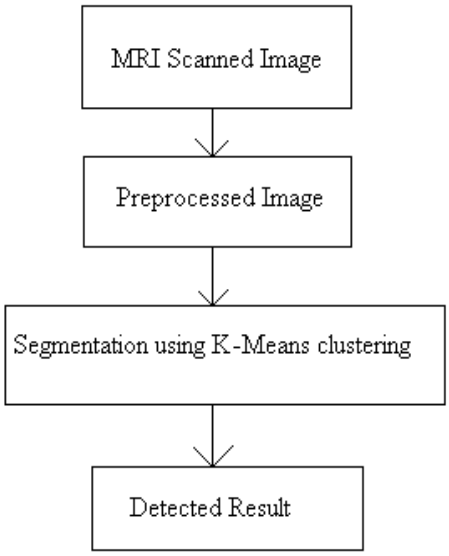
1. anomalies of the brain tumor and spinal cord
2. tumors, cysts, and other anomalies in various parts of the body
3. certain types of heart problems, diseases of the liver and other abdominal organs

This list is by no means exhaustive. The use of MR Image technology is always expanding in scope and use.

Magnetic Resonance Imaging (MRI) is an advanced medical imaging technique used to produce high quality images of the parts contained in the human body MRI imaging is often used when treating brain tumors, ankle, and foot. From these high-resolution images, we can derive detailed anatomical information to examine human brain development and discover abnormalities. Nowadays there are several methodology for classifying MR Images, which are fuzzy methods, neural networks, atlas methods, knowledge based techniques, shape methods, variation segmentation. Image segmentation is the primary step in image analysis, which is used to separate the input image into meaningful regions [3].

III. PROPOSED METHOD

We have proposed segmentation of the brain MRI images for detection of tumors using K-Means clustering technique. A cluster can be defined as a group of pixels where all the pixels in certain group defined by similar relationship. Clustering is also unsupervised classification because the algorithm automatically classifies objects based on user given criteria. Here K-Means clustering algorithm for segmentation of the image is used for tumor detection from the brain MRI images. The proposed block diagram is as shown [8].



MRI scans of the human brain forms the input images for our system where the grayscale MRI input images are given as the input. The preprocessing stage will convert the RGB input image to grayscale. Noise present if any, will be removed using a median filter. The image is sharpened using Gaussian filtering mask. The preprocessed image is given for image segmentation using K-Means clustering algorithm.

A. MRI Scanned Image

Images are obtained using MRI scan and these scanned images are displayed in a two dimensional matrices having pixels as its elements. These matrices are dependent on matrix size and its field of view. Images are stored in Image file and displayed as a grayscale image. The entries of a grayscale image are ranging from 0 to 255, where 0 shows total black color and 255 shows pure white color. Entries between these ranges vary in intensity from black to white.

B. Preprocessing

Pre-processing step translate the image, it completes filtering of noise and other artifacts in the image and sharpening the edges in the image. The RGB to grey conversion and Reshaping also takes place here. It includes a median filter for noise deduction. The opportunities of arrival of noise in modern MRI scan [6] are very less. It may reach due to the thermal effect. The aim of this paper is to detect and segment the tumor cells, but for the complete stage it needs the process of noise removal. For better understanding the function of median filter we added the salt and pepper noise artificially and removing it using median filter.

C. Segmentation using K-Means Clustering

Segmentation is an essential process to extract information from complex medical images. The main objective of the image segmentation is to segregate an image into commonly exclusive and exhausted regions such that each region of interest is spatially contiguous and the pixels within the region are homogeneous with respect to a predefined criterion.

D. K-Means (KM) Clustering Algorithm

Clustering is defined as the process in which similar objects are grouped together. Clustering is widely used in unsupervised learning. In K-means clustering, the objects are grouped together into k clusters where k is a positive integer. These k clusters are based on the similarity between the objects here in our case it is image pixels. K means groups the image pixels based on some features and similarity between the pixels. In this segmentation algorithm, the number of k clusters and their centroid points is computed randomly or by using some heuristic data. The straight line distance between each cluster centroid and the pixel is calculated. The pixel with the minimum distance is moved into the corresponding cluster. Again the new centre points are calculated by averaging the values of the pixels in the cluster. These two steps are repeated until the values of the central pixels do not change on average. K-means is one of the most widely used clustering algorithms when image data is large. It is simple and has less computational complexity [7].

Algorithm for K-Means:

Step i) Consider the number of cluster value as k.
Step ii) Pick the centers of k cluster randomly.
Step iii) Compute cluster's center or mean.
Step iv) Compute the distance between each pixel to each center of the cluster.
Step v) If the distance is close to the center then move to the particular cluster.
Step vi) Else, move to the subsequent cluster.
Step vii) Estimate the center again.

IV. RESULTS

1. Applying Our Proposed Algorithm

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Fig 2. Brain MR Images containing tumor the brain tumor location is found out by applying our proposed algorithm. Some of the brain MR Images containing tumor taken for testing our proposed algorithm are shown in Fig 2.

2. Clustering of brain MR image

Fig 3. Shows the final clustering of brain MR Image after being processed by our algorithm.

3. Tumor detected

Fig 3. Shows the final tumor detected portion from the brain MR image.

V. CONCLUSION

Segmentation of brain image is imperative in surgical planning and treatment in the field of medicine. In this work, we have proposed a computer aided system for brain MR image segmentation for detection of tumor location using K-Means clustering algorithm. The proposed brain tumor detection comprises three steps: image acquisition, pre-processing, and K-Means clustering. We were able to segment tumor from different brain MR images from our database.

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