ABSTRACT

Brain tumors are composed of cells that exhibit unrestrained growth in the brain due to uncontrolled replication in an abnormal way. The causes of brain tumors include smoking, heredity, toxic emissions from oil refineries, chemical and rubber industries, and exposure to ionized radiations. Brain tumor detection is one of the challenging tasks in medical image processing. Since, brain tumors are intricate and tumors can be analyzed only by medical experts. The brain tumors are diagnosed using several medical imaging techniques such as ultrasound images, Computer Tomography (CT) images and Magnetic Resonance (MR) images. CT uses multiple X-rays to produce cross-sectional layers that show detailed images in the body, whereas ultrasound imaging uses high frequency sound waves. Exposure to ionizing radiations in CT imaging system leads to increased risk of cancer and the ultrasound imaging results in higher false positives. The MR imaging (MRI) uses the natural magnetic property of the body to produce detailed images of any part of the body. The hydrogen nucleus (a single proton) is used for imaging. Thus the radio wave frequency (RF) will cause hydrogen nuclei to resonate dependent on the element sought (hydrogen in this case) and the strength of the magnetic field. When the body is subjected to a strong magnetic field protons' axes all line up. This uniform alignment creates a magnetic vector. At the time of switching off the radiofrequency source, the magnetic vector returns to its resting state, and this causes a signal to be emitted. This signal is used to create the MR images. The MR Imaging system prevents the human organs from ionized radiations.

The MR images provide an efficient way to diagnose the brain tumors, as it shows the detailed structure of the brain and the size and location of the tumor. As the structure of brain comprises of numerous folds, cerebrospinal fluids, gray and
white matter, the identification and detection of tumor becomes a crucial task. So, it is 
necessary to segment the brain images for detecting the boundaries and location of the 
tumor. During the past few years, brain tumor segmentation in Magnetic Resonance 
Imaging (MRI) has become an emergent research area in the field of medical imaging 
system. The existing segmentation techniques resulted in less accuracy, which in turn 
causes inefficiency in tumor identification. The challenges are resolved in both the 
phases of this research work.

In the first phase of this research work, the tumor detection efficiency is 
improved by grouping the similar objects into a group with the help of a clustering 
technique. Here, the K-Means clustering technique is used for brain image 
segmentation. Even though, there are several clustering methods available for medical 
image processing, K-Means clustering algorithm is used for rapid clustering of 
massive data in an efficient manner. Especially, in brain image segmentation, K-
Means clustering is the more prominent method that achieves high accuracy. But the 
manual initialization of the number of clusters and random selection of initial centroids 
of each cluster in K-Means clustering does not promise to produce the consistent 
clustering results. So, an alternate approach to initialize the centroids and the number 
of clusters in traditional K-Means clustering is proposed as Improved K-Means 
clustering in this research work. The method proposed to segment the MRI brain 
images in this phase of research work consists of two stages, namely, pre-processing, 
and segmentation using Improved K-Means clustering.

The raw brain images acquired through MRI scanning consists of noises 
and hence, it is important to filter out the noises and to sharpen the images before 
segmentation. Median filter is used to reduce the noise and also to preserve the edges 
in the image. The finer details of the brain images are obtained using Gaussian high
pass filters. The improved K-Means clustering algorithm is applied on the preprocessed brain MR images to segment tumor from the background structure of the brain.

The second phase of this research work proposes the Edge Following Contour Segmentation (EFCS) technique. Detecting the accurate boundary in brain images is a challenging task, so this analysis recommends a new edge following technique for correct boundary detection in brain images. The edge detection process serves to facilitate the scrutiny of images by intensely diminishing the amount of data to be processed, while at the same time conserving useful structural information about object boundaries. EFCS algorithm is proposed to detect the tumor portion and segment it from MRI brain image. Canny operator is an edge detection technique containing three processes, namely, edge detection, thresholding and edge thinning. The canny edge detection and Laws texture are used to derive the significant information about the boundaries. The canny edge detection algorithm is used as an optimal edge detector based on a set of principles to find edges by diminishing the error rate. Genetic Algorithm (GA) is a type of evolutionary system that simulates the process of natural selection over generations. Here, a genetic optimizer is used to predict a suitable threshold value for canny operator to detect the edges of image. GA based canny edge detection smoothenes the image for removing the noisy data and non-maximum suppression is utilized to track the tumor infected region. The main intent of this research work is to segment the tumor from brain image using the combination of canny operator and active contours.

The performance of the proposed method have been tested using the brain MRI images from BRATS2012 and DICOM Image Library data sets and real time data of Meenakshi Mission Hospital, Madurai. In the proposed EFCS, the level of
accuracy is increased. The main intent of this work is to distinguish the contour of tumor from the entire context of the brain. The performance of these approaches are evaluated in terms of Dice index, Accuracy, Sensitivity Specificity, Positive Predictive Value, Negative Predictive Value, False Positive Rate and False Discovery Rate. Experimental results shows that the proposed segmentation technique provides better results, when compared with the existing methods found in the literature. In addition to this, the proposed EFCS technique of phase II outperformed the segmentation method using improved K-Means clustering of phase I.