Literature Review of Segmentation and Classification of Medical Images

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Abstract: The brain tumor segmentation is one of the highly focused regions in the community of medical science. Brain tumor segmentation has been employed to define the tumor area to help for disease diagnosis and select the best methods for the treatment of diseases. It is a tool to separate a portion of the tumor from the entire image. This paper presents a thorough literature review of recent techniques of brain tumor segmentation. Several techniques of image segmentation are briefly explained with the recent contribution of various researchers.

Keywords: Segmentation techniques; MRI; Brain Tumor; Classification

1 Introduction

The brain tumor is a mass of abnormal cells. It consists of two types: malignant and benign. Brain tumor symptoms can be general or pre-defined. General symptoms are caused by tumor pressure on the brain or spinal cord. Pre-defined symptoms are caused, when a certain part of the brain does not function well due to a tumor. The researchers applied different imaging modalities to detect anatomical structures from several medical imaging systems [1, 2].

Brain tumor segmentation has been employed to define the tumor area to help for disease diagnosis and select the best methods for the treatment of diseases. It is a tool to separate a portion of the tumor from the entire image. Manual tumor segmentation methods consume time and effort, and thus also lead to the misdiagnosis of the disease. Brain tumor segmentation methods are divided into some types such as thresholding and region growing [3, 4].

Medical image segmentation is a significant stage for diagnosis of the diseases. The aim of medical image segmentation is to detect required region to help the specialists for better diagnosis of diseases. It divides the image into areas based on a deterministic description, such as segmentation of the body organs in the medical applications [5].

Segmentation is an important tool for image processing. Image segmentation is used to split the image to different numbers of objects and discrete areas. The result of image segmentation is a set of parts that comprise the entire image or a set of lines taken from the image. Different methods can be implemented to divide the images. Segmentation methods include thresholding, clustering, edge-based, region-based, graph-based, watershed and active contour segmentation techniques [6].

Medical image classification is one of the most significant difficulties in the image classification area. It aims for classification of medical images into several categories to aid specialists in disease diagnosis or further research. Overall, medical image classification is split into two steps: feature extraction step and classification step. In classification problems, an algorithm is used to classify the testing data into pre-defined categories, accurately. The common types of classification algorithms are linear classifiers, support vector machines, decision trees and random forest classifiers [7].

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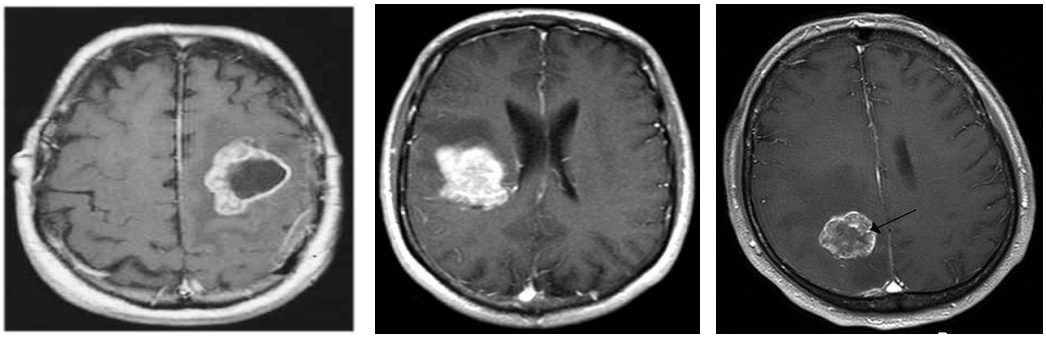
2. Segmentation and Classification of Brain Tumors

Segmentation and classification of medical images is a significant stage for better diagnosis of different diseases. This paper discusses the related work of segmentation and classification of brain images. The paper illustrates the different techniques that are applied for detection the brain area. Several researches are worked many studies for brain tumor segmentation and classification so that we present a thorough literature review of recent techniques of brain tumor segmentation. Figure 1 shows the brain tumor images.



(a) (b) (c)

Figure 1: Brain tumor images.

2.1 Brain Tumor Segmentation

The segmentation of brain tumors is a significant key for the localization of the tumor area for aiding specialists to define the best methods of disease treatment. Rajendran et al. [8] proposed an algorithm for brain tumor segmentation depending on fuzzy clustering and deformable models. This algorithm is integration between region-based fuzzy clustering and a deformable model that is used for the tumor area detection. At first, region-based fuzzy clustering is performed for initial segmentation. After that, the result of the fuzzy processing is used as an initial contour of the deformable model. Finally, gradient vector field is used to localize the tumor boundaries, exactly.

Sheela et al. [9] introduced a system for segmentation of brain tumors. This system begins with eliminating the healthy region by performing dilation and erosion processes. Greedy Snake algorithm is employed for the segmentation process to localize the tumor boundary. Fuzzy C-Means algorithm is performed to obtain the segmentation output, accurately. Figure 2 clarifies the block diagram of the brain tumor segmentation process.

Another attempt for brain tumor segmentation was introduced in which fuzzy C-means algorithm is employed for region growing. Region growing is performed to fuse the pixels in a larger region. Morphological operations are applied to enhance image quality. The Gaussian filter is applied to obtain the output. The seed point is set to determine the tumor area only [10]. Figure 3 shows the block diagram of the brain tumor detection process.

Devkota et al. [11] presented a system for brain tumor segmentation. The mathematical morphological operations are employed for the segmentation process. At first, the noise is eliminated by employing the median filter. Then, mathematical morphological operations are applied. A large number of textural and statistical features are extracted from the segmented image to detect the normal and abnormal region from the whole image.

Maheswari et al. [12] proposed a technique for the brain tumor segmentation. This technique used K-means method and fuzzy c-means method for brain tumor segmentation. The segmentation is performed by K-means clustering. In addition, fuzzy C-means clustering is applied for more accuracy. The Local

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Independent Projection-based Classification (LIPC) is applied for the classification process. It is used in synthetic and real-time datasets. Table 1 illustrates the different algorithms of brain tumor segmentation.

El-Hag et al. [13] presented a technique for brain tumor segmentation. The technique begins with a fusion process of CT and MR images. After that, the optimization process is applied. The hybrid method is used to detect the tumor area. The hybrid method consists of threshold and watershed segmentation methods. Morphological operations are applied finally to shape the tumor object.

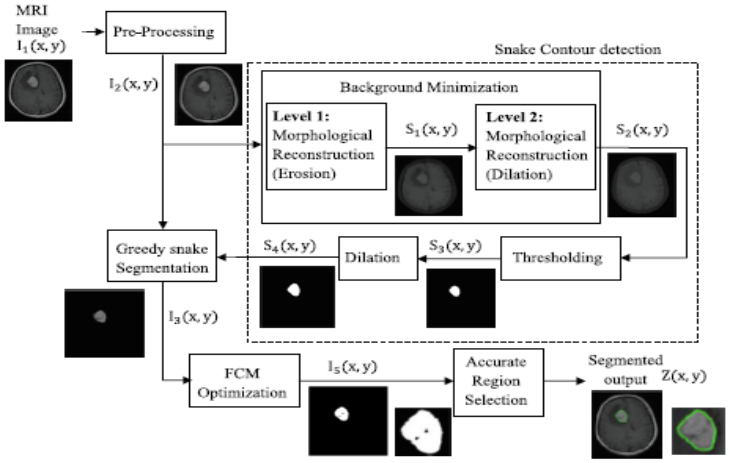

Figure 2: Block diagram of the brain tumor segmentation.

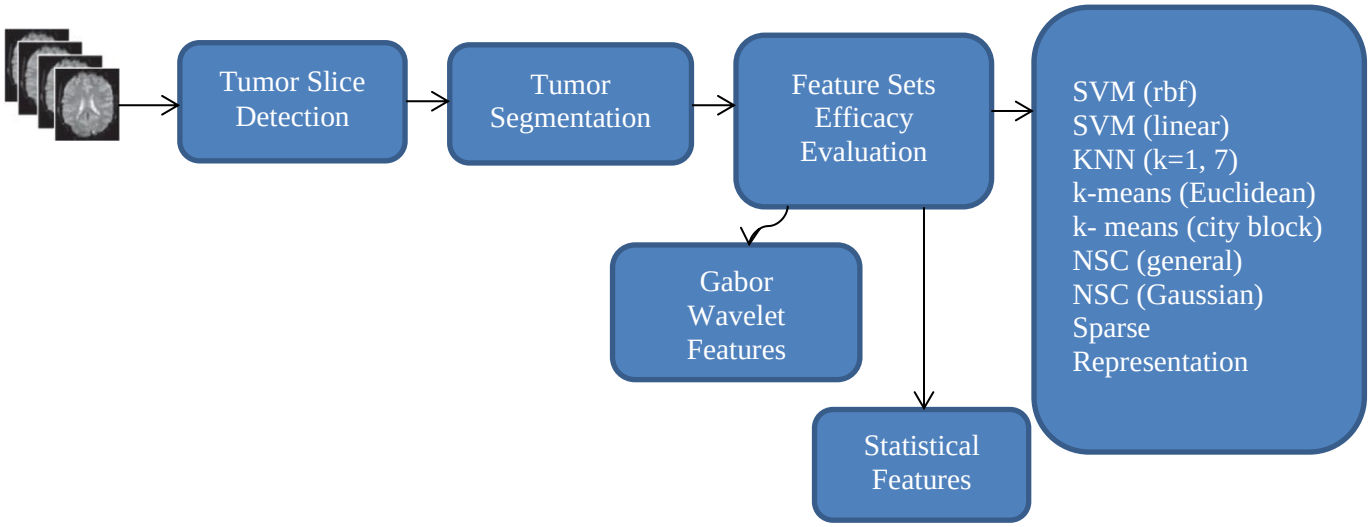

Figure 3: Block diagram of brain tumor detection [29].

Table 1: Different algorithms of brain tumor segmentation

Author	Algorithm
Nabizadeh et al. [2015]	Region growing algorithm
Devokta et al. [2018]	Mathematical morphological operations
Sheela et al. [2019]	Fuzzy C- means clustering
Maheswari et al. [2021]	Fuzzy C- means an K- means clustering

2.2 Brain Tumor Classification

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It is used to discriminate between multiple image sets. Image classification is the process of classifying and labeling pixel sets within an image depending on certain rules. The classification law can be formulated using one or more spectral or textural features and properties. The two major methods of classification are supervised and unsupervised. Supervised learning is a machine learning approach that depends on labeled datasets. These datasets are designed to train algorithms to accurately classify data or predict outcomes. The model can evaluate its accuracy and learn over time by using input and output labeled data. Unsupervised learning uses the algorithms of the machine learning for analysis and clustering of unlabeled datasets. These algorithms discover the unseen patterns in data without the need for human intervention [14].

Brain tumor classification is an important indicator for discrimination between healthy and non-healthy cases. Raja et al. [15] presented an approach for brain tumor classification. At first, the non-local mean filter is used for the denoising. The segmentation approach is implemented by Bayesian fuzzy clustering. After that, some methods are used for extracting the features such as information theoretic methods, scattering transform (ST) and wavelet packet Tsallis entropy. Finally, a hybrid method for the deep auto-encoder based Jaya optimization algorithm with a soft-max regression is performed for classification.

Swati et al. [16] introduced a technique for brain tumor classification. The system is a pre-trained deep learning model (VGG19), which is implemented for classification. The VGG19 is decomposed of 16 convolutional layers, and three fully-connected layers. It is evaluated on T1-weighted contrast-improved MR images. It achieved an average accuracy of 94.82% under five-fold cross-validation. Figure 4 illustrates the block diagram of classification of MR brain images.

Zhang et al. [17] proposed a system for brain tumor segmentation depending on CNN. It depends on a cross-modality deep feature learning attempt for brain tumor segmentation from the multi-modality MR images. The cross-modality deep feature learning consists of two processes: cross-modality feature transition process and cross-modality feature fusion process. Figure 5 illustrates the block diagram of the brain tumor detection. Table 2 shows different algorithms of brain tumor classification.

Other studies are proposed for brain tumor segmentation. Different techniques are applied for segmentation process such as K- means clustering, Otsu, adaptive k-means, threshold and watershed segmentation. These techniques are used to separate the tumor area from the whole image [18-20]

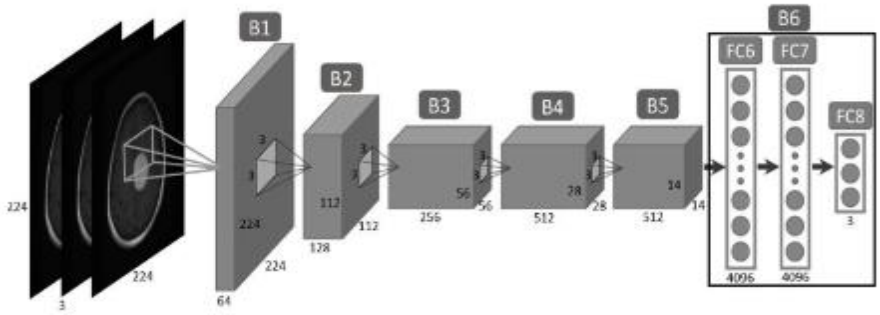

Figure 4: Block diagram of classification of MR brain images.

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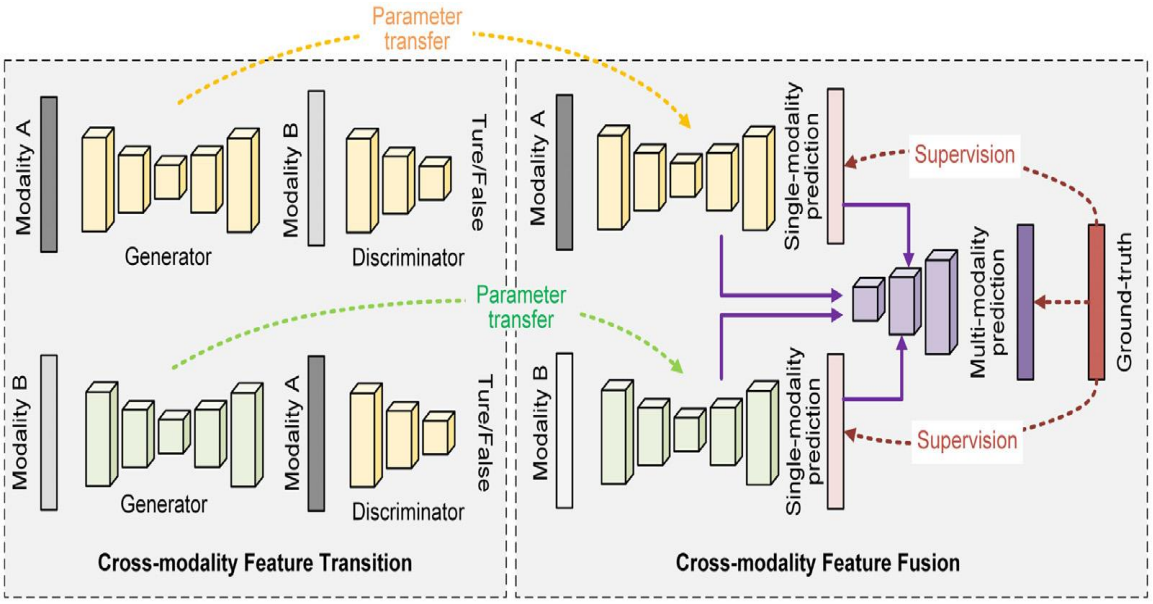

Figure 5: Block diagram of the brain tumor detection.

Table 2: Different algorithms of brain tumor classification

Author	Algorithm
Swati et al. [2019]	Pre-trained model VGG-19
Raja et al.[2020]	Deep auto-encoder based jaya optimization algorithm
Zheng et al. [2021]	Cross-modality feature transition process and cross-modality feature fusion process

3. Conclusion

The paper presented different techniques to detect and segment brain tumor images. Segmentation and classification of brain images are the most significant steps for diagnosis of several diseases. The fuzzy C-means and K- means clustering are the most widely used methods for brain tumor segmentation. The deep learning models are the most appropriate models for brain image classification. The CNN is the most widely used for brain image classification in the last few years.

Conflicts of Interest: The author declares that there are no conflicts of interest.

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