BRAIN MAGNETIC RESONANCE IMAGES SEGMENTATION TECHNIQUES: A REVIEW

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Abstract: In this paper a thorough review of various Magnetic Resonance Images (MRI) segmentation techniques is presented. MR image segmentation techniques are used in clinical establishment to diagnose various types of diseases. Segmentation of MRI is a challenging task. Automatic segmentation as compare to the manual segmentation of MRI is helpful to do the segmentation easily and in less time to extract an interested area from an image. Segmentation of brain MRI is the significance for diagnosis brain disease. Various segmentation techniques are available which are used to segment an MR image like thresholding, clustering, region growing, watershed algorithms, machine learning, deep learning and neural networks, etc. Each and every segmentation technique has its own advantages, and limitations. These segmentation techniques provide us an efficient approach to segment the brain MRI for detect the brain tumor.

***Keywords*-Magnetic resonance images, Brain tumor, Image segmentation, Image segmentation techniques.**

1. INTRODUCTION

MRI is the most usable medical imaging technique to detect the brain tumor. MRI is scanned by using the magnetic field and radio wave energy pulses. These radio waves or radiations are not very harmful for the human body [16]. The most important and biggest component of MRI is a magnet. Mostly a superconducting magnet is used by the MRI systems and these magnets are known as ring magnets. Magnet contains various coils and wires and through these coils and wires electricity is passed to capture an image. To capture the MR image magnets go through the body for bring out the hydrogen atoms. After these atoms are reached to their normal level of the stimulation than they give an energy which is detected on the scanner. In MRI scan basically three types of electromagnetic fields are used, static field, gradient field and radio frequency field [16]. Static field is known as a strong electromagnetic field, the gradient field is weaker than compare to the static field which helps to do the spatial encoding and radio frequency or weak radio frequency field is used to manipulate hydrogen nuclei for obtaining the signal which is captured by the antennas. By scanning the MRI a digital image is obtained then stores it into the computer system for further study.MRI provides us a high resolution image of brain [17].

There are four types of sequences or scanners are available for MRI scan, T1-W, T1-c, T2-W and Fluid attenuated inversion recovery (FLAIR). MRI is the most widely used technique by the radiologist for better visualization of the internal body parts [19]. MRI considered as a best method to detect the brain tumor from the brain and also from spinal cord [14]. The better visual quality of the MR images plays a vital role by giving us the accurate results. There is also no any side effect for human body to do the MRI of the brain. It takes 20 to 60 minutes approximately for scan the brain or any body part. Main limitation of the MR scan is its acquisition time. To reduce or overcame this problem gradient is increased for the fast MR scanning.

The unusual growth of the brain cells are known as a brain tumor [21]. Manual segmentation is very time-consuming and subjective process while automatic segmentation is a challenging because of the complicated structure of brain and large number of brain tissues [24]. The automatic techniques of the segmentation is desired for obtaining the consistency and quantitative analyses
[24]. A brain tumor effects on the working of the nervous system, and it depends on its position and rank of growth inside the brain [25]. Brain tumor has two types - Primary brain tumor and Secondary brain tumor.

- Primary brain tumor is begins inside the brain. They can be either benign (non-cancer) or malignant (cancerous).

- Secondary brain tumor is a part of tumor which begins in another part of human body like kidney, etc. then extends to the brain. Secondary brain tumor is also known as a brain metastases and much commoner than the primary tumor. Tumors from the skin, platelets and lungs when spread to brain then it create a metastatic cancer of brain [30].

Glioma is part of brain tumor which has two types defined as a low grade (LGG) and high grade glioma (HGG). The low grade glioma generally grows slowly and the high grade glioma grows faster than low grade. Brain MRI contains various types of tissue categories of brain like white matter (WM), grey matter (GM), cerebrospinal fluid (CSF) and its background.

2. IMAGE SEGMENTATION

The main purpose of the segmentation is to separate image surface into finite number of consistent regions and objects which are similar and dissimilar in form of their colour, intensity, etc. Many types of segmentation algorithms and techniques are there to segment a brain image for find out the tumor region based on various types of properties like edge detection, thresholding, classification, clustering and region growing etc. It is necessity of the fast and accurate automatic segmentation techniques to segment brain structure in MR image [26] and to do the segmentation easily and accurately of brain tumor is very essential step so automated segmentation methods are needed and helpful for extract the brain area [28]. The accuracy of the results of segmentation techniques decides the success/failure of the process. The segmentation accuracy to the tumor or glioma is much important not for the treatment only but also to the evaluation. In various clinical applications like imaging guided and surgical planning accuracy of the brain tumor segmentation in MRI has an important role [29]. Segmentation provides various improvements into an image. It makes possible for the users to analyze an image. Segmentation provides us measurements and mapping procedures. The main aim of segmentation is to simplify an image into something which is more meaningful and easy to visualize, like brain tumor, it causes brain swelling and increase the pressure into the skull [30].Automatic and accurate skull/brain extraction techniques are required for speed and accuracy improvements in the clinic applications [31].Segmentation is main process for analysis the medical images. For segment the brain tumor there are various methods which develop the parametric and non-parametric models. For feature extraction into an image firstly segmented an image after segmentation process extract text features from an image.

3. IMAGE SEGMENTATION TECHNIQUES AND LITERATURE SURVEY

3.1. REGION GROWING SEGMENTATION

Region growing is a method of the region based segmentation. Region based segmentation works based on pixel similarities in a particular image. Region based segmentation are very helpful to do the segmentation when homogeneity criteria of regions is easy to evaluate. It basically works by selecting the initial seed point from an image. In region growing method an image pixels are grouped into sub regions [1]. To group the pixels into sub regions the seed particles are selected from an original image. After that similarity and dissimilarity is defined based on these seed particle properties. Then the regions are grow by add each and every seed pixel value which are similar in nature. In region growing method of segmentation growth of the regions is depend on the homogenous pixel values over a seed. This homogeneity process not only depends on consideration problem, also depend on the available image datasets [4]. By using the region growing method we can partition an image to non overlapped sub regions [2]. This technique of segmentation accurately separates the image regions and gives us a good result of segmentation [2].We can also estimate the region of interest (ROI) in region growing methods by following the multimodal images like T1, T2 or Flair image [9]. Region growing method of segmentation is iterative approach with three parts as, selection of seed points, similarity and convergence criteria.

Siddhi N.Nerurkar, (2017), they proposed region growing and clustering methodologies of segmentation in this paper to detect the brain tumor. For the medical images various types of segmentation methods are available but clustering and region based algorithms are more efficient, accurate and also fast. Region growing based segmentation is used by this paper after k-mean clustering to create the sub regions of the image. By region growing method image is dividing into sub regions based on pixel similarities. At the end output of these two algorithms is compared by accuracy. The result shows that region growing algorithm is more accurate than k mean clustering. This is the best method of the segmentation. [1]

K. Somasundaram et al., (2018), this paper presented that segmentation requires the initial seed value which is very costly process and which have a high execution time [2]so improve this problem they proposed the region growing methodology for segmentation of brain MRI. In region growing method each pixel is called as a seed and grows along with the neighbouring pixel values for extraction of the brain tumor from MRI. It helps to partition the input image into the non overlapping regions. This method segments the regions of image correctly. The performance of this methodology is estimate by dice and jaccard algorithms. Erosion is applied on the binary images only for de-connect the weak objects into the clusters. In dilation operation lost pixel by erosion process are recovered through some structuring elements. Dice and Jaccard are calculated of the input images given from the IBSR. They conclude that proposed methodology region growing is better than existing methods of segmentation. [2]

3.2. THRESHOLDING BASED SEGMENTATION

Thresholding is used to convert the greyscale image into binary based on the threshold points [3].Image thresholding is a simple as well as an effective way of partitioning an image. Single threshold value partition an image into two values 0(black), 255(white). This technique is applied on image for segmentation by converting greyscale images to binary images. Threshold value is selected by grouping the pixels of an image and then extracts that image for segmentation [4]. Whenever the T value is increased then it gives us increased number of the pixel intensity values into the segment image. Thresholding is important and common technique for do the segmentation by image pixel values [19].

$$f(x,y) \geq T;$$
$$f(x,y) \leq T;$$

Shubhangi S.Veer, Dr. P.M Patil, (2015), by selecting a good methodology of segmentation it is easy to get the accurate results and to detect the tumor region from brain image. This paper proposed the global thresholding to the segmentation. They follow up three stages pre processing, segmentation and tumor measurement in their research. When we take an input image if any noise is present into the image because of sensor temperature, insufficient lighting etc. then in pre processing this noise or blurriness is removed by using any filter like linear filtering. Then thresholding based segmentation is applied to identify boundaries, objects of an image. Global thresholding technique of segmentation is proposed which extract the tumor from brain MRI by single threshold value. Global thresholding convert the image from

greyscale to binary image based on the threshold value. At the end tumor area is measured in terms of the white pixels because segmentation proposed methods separate the tumor from brain MRI successfully. [3]

Jyotsna Dogra, Navdeep Prashar, Shruti Jain, Meenakshi Sood, (2018), along with the different techniques of segmentation thresholding is a simple technique which helps to extract the ROI from the image background area by compare the pixels with T [4]. They proposed the thresholding technique also involving the graph cut method. One threshold value helps to segment an image into the two type of image intensity that is 0 and 255. 0 belongs to the black colour and 255 belong to the white colour. Whenever the threshold value increased then intensity value is also increased in the image. If we want proper segmentation then we have to apply a correct threshold value. In the graph cut method image centroid values are selected automatically. Initial centroid value is obtained by converting the image into two parts horizontal and vertical. This paper compare the thresholding and graph cut method and conclude that the performance of graph cut method is better than thresholding. Peak signal noise ratio (PSNR) and Structured similarity index method (SSIM) parameter values of image segmentation also shows that graph cut method is effective than thresholding. [4]

3.3. CLUSTERING BASED SEGMENTATION

Clustering a process of segmentation is used to collect together the similar type of object and the dissimilar objects are collected in another cluster. To check the similarity and dissimilarity between two data clusters, distance between the two images is calculated. This method of segmentation is also called as an unsupervised method because algorithms classify the objects automatically based on user criteria [16]. A clustering technique is used to obtain a partition of n objects by using a suitable measurement. Clustering segmentation has two types of algorithms, k-mean clustering and fuzzy c-mean clustering.

3.3.1. K-means Clustering

K-mean clustering is used for grouping the N pixels from an image to K number of clusters [1]. The big advantage of k mean clustering algorithm is its simplicity and less cost of computational. K-mean clustering is an unsupervised technique of clustering [25]. By using this algorithm we are able to find out groups in the datasets [25]. By using the k mean clustering we can cluster an image clearly to detect the tumor from MRI. This is also called as a hard clustering. In k-mean clustering the image pixels are grouped. The main advantage of this algorithm is its simplicity & low cost of implementation. It runs effectively on large number of data sets. In the traditional algorithms of k mean clustering numerous issue are there which gives us less accuracy in segmentation.

Leila et al. (2018), proposed methodology used for brain tumor is k mean clustering and genetic algorithms. K-mean clustering is unsupervised technique of classification. It is includes for group the patterns which patterns are similar then they belongs to same cluster. This is a big issue to decide the similarity between patterns. K mean clustering algorithm is most widely used algorithm which helps to solve the problems. It is used to divide the image into *k*number of clusters. Centre for each cluster is randomly selected from the data. [5]

OyendrilaDobe et al. (2019), proposed rough set k mean methodology to segment brain T1 W MRI. To the accuracy of the segmentation rough set algorithm of k mean clustering is implementing based on the rough set theory? In traditional algorithm of k mean clustering each pixel is clustered by hard partition of data. Which pixel belongs to one cluster then that pixel can't belong to the other cluster. So sometime there is an error occurred in the boundary pixels. But in rough set k mean algorithm pixels are associated to the more than one cluster. Which boundary pixel has same probability then they belong to the more than single cluster. [6]

Gnaneswara Rao Nitta et al. (2019), proposed the novel k mean algorithm based on gray level of an image. Gray level of MR image is extract by converts it to the gray scale image. Rather than randomly selecting the centroid value, first 16 probabilities of the dominant gray pixel values are selected as the initial centres. This novel approach of k mean clustering has a better performance as compare to the existing/traditional k mean clustering algorithms. [7]

3.3.2. FUZZY C MEANS CLUSTERING

Fuzzy method of clustering is called as a soft clustering. This classical technique provides us the soft division of the data [8]. It is also known as a soft k-mean. Fuzzy c-mean has some similarities with the k-mean clustering algorithm, but there is one difference that it cannot give any type of hard constraints on an image. It will apply on grey level as well as colour images. This algorithm of clustering is famous because of its ability of handling the problems of artificial intelligence. The fuzzy c-mean is most widely usable method. When there is a noise present in any image then for doing the better image segmentation Fuzzy clustering algorithms provides us close attention by using the local and some non local information into the images [8].FCM is very helpful to find the region of interest (ROI) from the multimodal MRI [9]. This algorithm provides us the accurate outcomes for that type of data which is exist in overlapped form. If we compare it with the k-mean clustering then it has a better performance. Fast generalized algorithms of Fuzzy c-mean are helpful to reduce the problem of time complexity [20].

Li Guo et al., (2018), fuzzy clustering provides us data into soft partitions [8]. The proposed technique in this paper to segment the image is fuzzy clustering. Guided filter improve the image quality or enhanced the image so, it is known as a powerful filter. Guided filter change the pixels and guide an image. General framework of fuzzy clustering is designed in this work to the improvements in the noisy images for segmentation after apply the guided filter. Fuzzy c mean divides an image into c clusters. FCM can't fully include the spatial information utility in segmentation of image. FCM is a sensitive method for the noisy pixels. In fuzzy clustering process each cluster is calculate by the membership property. [8]

Qingneng Li et al., (2018), glioma is segmented in this paper by using novel algorithms on the multimodal MR images. Fuzzy c mean is included for estimate the ROI and after ROI estimation some seed points are extracted by region growing methods. Multimodal images

include the T2 and FLAIR image. Fuzzy clustering algorithm is justified to the fast algorithm for segmentation of medical images. In this paper research is done on 220 patients of HGG and 54 patients of LGG by fuzzy c mean algorithm. FCM not exclude the noise of image. Accuracy of glioma segmentation is defined by dice, PPV and sensitivity value. Value of dice in result is 086. Sensitivity is 0.84 and PPV is 0.90. [9]

3.4 WATERSHED ALGORITHMS OF SEGMENTATION

Watershed algorithm is usable in image processing for the image segmentation. It is an algorithm which works based on some mathematics morphological methods for image segmentation. Watershed transform in the time of processing used the gradient magnitude of an image. Which pixels of image have highest gradient magnitude; they considered on the watershed lines and then define the boundaries of the region. In this algorithm pixels of the image are grouped by identify the image intensity [3]. The basic concept of the watershed method to visualize the image in three dimensions, two spatial coordinates intensity. Watershed is a best method for the segmentation of the brain MRI [3]. In this topographic interface two types of points are considered like points belonging to a regional minimum, points were a drop of water. The main disadvantage to the watershed algorithm for the segmentation is necessity of the de-noising process [10].

K.S. Tamilselvan et al. (2013), proposed the watershed algorithms and wavelet transform for detect the tumor. They shows that in first step input image is decompose by using wavelet then detailed image is segment by watershed algorithm. Watershed algorithm provides us a fused image. Watersheds are the regions in topography field. In digital image processing greyscale images are known as the topographic images. In watershed algorithms image gradient is used and its regions are creates by the region growing method. In this paper by watershed algorithm initially low resolution segmentation is obtained. [10]

3.5 CONVOLUTIONAL NEURAL NETWORKS BASED SEGMENTATION

Convolutional neural networks (CNNs) are the sub class of the deep neural network. CNNs are used to analyze the visual imaginary. CNNs are the variations of the multiple layers. CNN has small pre- processing if we compared it with other classification algorithms. CNN is helpful to give us breakthrough results. CNN works by convolving signals or kernels of an image to provide the feature maps. The weight of filters or kernels are decided at the training phase for enhanced the characteristics of given inputs [18]. From few years ago CNN become a very famous tool into the computer vision [22]. CNN contain layers and these layers prepared further operations on the datasets [22]. CNN performs for the machine learning without containing handcrafted features. CNN based segmentation algorithms are categorized into two parts like 2D and 3D based methods [23]. These 2D and 3D methods are achieved accurate segmentation outcomes except the manual designed input features [24]. Architecture of 3D CNN is mostly avoided because of its computational and more memories requirements [26]. The big advantage of 2D CNN approach as compared to 3D images is less computational and requirements of memory [26]. Traditional CNN like AlexNet demand for the fixed size input images and also follow the pool layer to decrease the spatial resolution. In Fully convolutional neural network (FCNN) unlike traditional architectures of CNN arbitrary size of images are allowed to apply [26].
Some stages of CNN are:

3.5.1. Initialization

It is an important task to achieve it. This process is used to get the convergence [12].

3.5.2. Activation Function

This process is responsible to the non linearity of the transforming data [18].

3.5.3. Pooling

This process joint the close features into the feature map [12] [18].

3.5.4. Regularization

It also used to reduce the over fitting [18].

3.5.6. Data Augmentation

This process helps to increase the size of datasets and reduce the over fitting.

3.5.7. Loss Function

These functions are minimized in the training [12] [18].

Chenjie Ge et al. (2018), proposed methodology is CNN architecture and also apply sensor fusion in this paper. Collected data has two categories, low and high grade glioma classification, with and without 1p19q glioma classification. Multi sensor used by this research paper expects the better performance by the researchers. Sensor fusions are included to the feature extraction. There are three types of sensors like T1, T2 and flair and each slice size is $128 * 128$. Under CNN architecture fully connected layer along with activation function of Relu includes to get the final classification. They also help to give the information of non linearity of data. The accuracy of first classification is 90.87% and second classification is 89.39%. The proposed methodology obtained the good performance. [11]

R.Vinoth et al. (2018), work is done by convolutional neural network (CNN) and support vector machine (SVM). Proposed method consists of three steps- pre processing, CNN, post processing for output. In CNN architecture various layers are works with some stages of CNN. These stages are the initialization, augmentation of data, pooling and loss function etc. Then in post processing which clusters are missed due to CNN are processed to find the tumor. By CNN LGG and HGG is identified, they are basically edema and enhanced tumor. This paper shows that identification of brain tumor is predictable by using the CNN. CNN helps to find parts of LGG and HGG. SVM is a very good technique used by various researchers. Some parameters contained by this paper are: variance, entropy, means, standard deviation, kurtosis, smoothness, IDM, correlation, skewness and homogeneity. These parameters are calculated in this work for identify the type of the tumor. They proved that SVM is best technique for the classification of data. [12]

Aimin Yang et al. (2019), proposed the CNN methodology for brain tumor extraction based on multi channel input CNN. In the traditional CNN based architecture we take the input image directly as data. The image contains redundant data. To avoid this problem new approach of CNN is used the saliency detection method in which an image is divided based on super pixel values then these super pixels are taken as a novel input networks. These super pixels are taken as input basically in three channels and use for the extraction of features by using down sampling and convolutional operations. Down sampling is next layer from the convolutional layer. [13]

3.6. IMAGE HISTOGRAM

Image histogram is useful and very helpful for us to understand an image with graphical representation with the tonal variations of an image. It is basically known as a graph. It represents the number of pixels for the each tonal value. By saw and understand the histogram of an image the viewer and researchers are able to find out the tonal distribution of the any type of image. Histogram method of segmentation followed the gradient values of an image which lies on the two axes, x and y [14]. The histogram has many uses- but mostly it is used to choose the threshold value for the thresholding method of segmentation. Histogram equalization is an efficient an automatic technique to the image enhancement. Histogram gives us general ideas for understand an image. It helps us to quickly visualization of data when we have the large amount of datasets. It gives us the skewness of the data. It is very helpful where the data is in numerical form.

Vasileios C.Pezoulas et al., (2017), this paper proposed a skull stripping methods based on some algorithms of normalized cut method. Histogram is acquired for the more accuracy of the results and this approach is applied on the skull free images. Skull stripping is very efficient approach for removing the skulls of brain. After this skull be removed then histogram based tissue classification is applied on each slice of image. Histogram technique use the gradient field of an image on x and y axes. The gradient value used by histogram is applied as the threshold. Histogram is classified into three classes like edema, necrosis and healthy tissues. [14]

Sandabad Sara et al. (2015), proposed the histogram analysis study to find the threshold intensity value for tumor detection from MRI. This paper says that histogram is known as a graph which includes identifying the distribution of values selecting from random value. By using the histogram of an image we can easily do the segmentation or classification. This is done by following any method like thresholding. Histogram shows that tumor is beyond the intensity value (greater than threshold T value). The automatic segmentation method of histogram follow by this paper only contains the injection of contrast rather than the location of an image. [15]

3.7. OTHER RELATED EXISTING TECHNIQUES

Rohini Paul Joseph et al., (2014), proposed the work of brain tumor MRI segmentation by using k mean clustering algorithms and morphological operations. They implement the automated segmentation to detect the brain tumor from brain MRI. Segmentation of an image plays a vital role as it helps us to extract the suspicious area from an MR image. After taking an input image in first step pre processing is done, it converts the RGB image into the greyscale image. Median filter is also applied in pre processing stage to remove the noise if present from an input image. After this for the image segmentation image is given to the next step to apply k mean clustering algorithm. Cluster is used to define the number of pixels into a group. Clustering technique of segmentation is called as an unsupervised technique. Which pixel value has similarity in image then they belong to the certain group. Morphological operations help to avoid the occurrence of miscluster regions from image. These operations are applied after k mean algorithms because by apply this algorithm for the segmentation process the chances of miscluster regions became high in an image. Morphology is basically a study about the shape and structure of the image. There are mainly two morphology operations erosion and dilation. Erosion gives the result as thinning of image objects and dilation gives the result as thickening of objects. This paper is able to do the segmentation of tumor from different MR images of brain taking from the databases. [16]

M.Kadkhodaei et al., (2016), this research is done for automatic segmentation on multimodal images of brain tumor. These multimodal images are segmented based on intensity by using the super voxel and saliency detection. They used the T1c, T2 and Flair MR Image channels in the proposed technology. Basic steps in this research are: pre processing, image channel fusion, segmentation of super voxel, feature extraction and classification. In first step of pre processing T1c, T2 and Flair channels are enhanced using unsharp masking methodology. This methodology helps to improve the quality of images. After that image channel fusion concatenate three types of sequences of MRI together to create a RGB image for getting the combining information about the brain tumor. Super voxel segmentation provides us a meaningful clusters of the voxel based on their features. Feature extraction has further two types feature extract by saliency feature and by texture feature. Saliency feature algorithm helps to visualize only important regions. In texture feature variance, mean, skewness, entropy, range and kurtosis are measured from histogram of voxel for every sequence. In final step classification is done by neural networks to detect brain tumor. [17]

Sergio Pereira et al., (2016), proposed the research by using the convolutional neural network (CNN). CNN contains 3*3 filters or kernels. By using the small kernels a better architecture is developed and also it has a benefit of the over fitting. This paper includes three stages. First stage of pre processing altered the MR image. By normalized the MR image mean and standard deviation values are computed for all types of training patches. Then these patches are also normalized by unit variance and zero mean. Second stage is to do the classification by CNN.

CNN includes convolutional layers by using small kernels. The kernel weight is decided in training phase to improve the enhancement of the input data. Activation functions are applied which are responsible to the non linearity of data. CNN is designed to remove the complexity and for the normalization of every tumor like HGG and LGG. At last post processing is done for removing some unnecessary conditions. They evaluated their proposed methodology on BRATS 2013/2015. It obtained first position from the online evaluation platforms by concern with 2013 datasets and also get the second position while concern with 2015 datasets. [18]

Dimple Kapoor, R.Kashyup, (2016), presented an automatic segmentation approach of self organized and neural networks. From an input image stationary wavelets are helps in this paper to extract the image features. Skull stripping algorithm is also a proposed technology of this paper. Pre processing is done to reduce the noise and distortion from input image. To reduce or remove this noise Weiner filtering is followed. It is very helpful to improve the Peak signal noise ratio (PSNR) of an image. This filter has a better performance than the anisotropic filtering. Then segmentation is proposed to detect the brain tumor by self organizing map (SOM). SOM is a part of the artificial neural networks [19]. This methodology shows that they perform better work as compare to the existing techniques. Skull stripping algorithm is very good approach for the brain tumor segmentation because it is used to remove the fat, skull etc. from the brain image which are not required. For the skull stripping labelling method and blob detection are main parts of this paper. [19]

Vaishnavi Avachar et al., (2017), hardware implementation is proposed methodology of this paper. They implement the fuzzy set algorithm and rough set algorithms on TMS320C6748 kit of digital signal processor. Digital signal processor (DSP) is a type of microprocessor helps in multiple operations of the digital image processing is followed by this research. This processor contains fixed and floating point architectures. DSP includes because it is very suitable for the numerical algorithms. The fuzzy set is used to handle the uncertainty of the pixel values. Fuzzy rough set helps to handle the lower and an upper approximation decides through the histogram. Then multi level thresholding is follow to segment an input image into three types of classes like WM, GM and CSF. This paper use the simple thresholding methodology for removes the complexity into the algorithm. [20]

Remma Mathew A, Dr.Babu Antop, (2017), proposed the morphological operations and Ostu's thresholding to the classification and detection of tumor from MRI. Pre processing is done by anisotropic diffusion filter. This is a very powerful filter and it defines the diffusion process. Thresholding and morphological operations are helpful in this paper to detect the boundaries of the tumor region. After segmented the image is gone through the wavelet decompositions. Discrete wavelet decomposition (DWT) is included by this paper to extract the features of the pre processed image. Then these features are given to the support vector machine (SVM) as an input. Classification is done by this SVM on the given input data. SVM transfer the input to high dimensions feature space by using the non linear map functions. SVM classification is best classifier advice by the various researchers. SVM after classify the images give the results as normal form, medium and critical form of image. By these results classification and segmentation is done of brain tumor MR image. [21]

Fausto Milletari et al., (2017), this paper presented the novel approach to segment brain region by using CNNs. They used the Hough voting under CNN architecture. This paper considered the Hough voting CNN technique which allows the fully automatic segmentation. Large number of parameters is included with CNN architecture like training set and patch dimensionality. Hough voting is a patch based multi atlas method. From the Foreground and background patches are collected and trained through CNN. It contains the voxel wise classification with the upper level features. CNN includes the various layers that perform the operations on the data. Pooling layer of the CNN architecture used to reduce the dimensionality. Parametric rectified linear is used in their proposed methodology as an activation function. All networks are trained nine times by this research. [22]

Qi Dou et al., (2017), in this paper for the automatic segmentation deep CNN achieved a good success in medical images. The proposed 3D fully convolutional architecture and 3D deeply supervised network (DSN) are efficient to get volume to volume inferences. The 3D CNN architecture is good to eliminate the redundancy of the patch based methodology. 3D CNN main components are convolutional layers, some sub sample layers. In fully CNN architecture arbitrary sized data is predicted. 3D deeply supervised network is helpful to guide the both lower and upper layers. They applied the 3D DSN on the liver 3D CT scans and on heart 3D MRI. 3*3*3 kernels are adapted by this task under CNN architecture. To learn these kernels clearly is an important task for the accurate results. This paper concludes that features extracted by the 3D DSN have low correlation as compare to the 3D CNN. Dice and Jaccard coefficients measured the overlapping segmentation result R and ground truth G. Parameters of dice and jaccard are: [23]

$$Dice = \frac{2|R \cap G|}{|R| + |G|}$$

$$Jaccard = \frac{|R \cap G|}{|R \cup G|}$$

Hao Chen et al., (2018), presented the novel approach of voxelwise residual network to brain segmentation from 3D MRI. VoxResNet contains total 25 layers. In VoxResNet method of segmentation shape information of image, low level mage feature and high level features are combined for the performance. VoxResNet is a very powerful tool for brain studies. VoxResNet based segmentation is perform on the multimodal images of MRI like T1, T2, T1c and flair images. The information provided by these multimodal images is robust which gives the robust results. Generally deep residual technique was developed for the 2D images, but this paper applies the residual network on 3D images by developing the effective schemes to handle the segmentation on 3D MR images of brain with the deeper network as compare to the existing literature. The proposed automatic segmentation is very powerful tool for neuroscience and neuron-images study. [24]

R. Pardeep Kumar Reddy et al., (2018), proposed the k mean clustering and triangular model to detect the brain tumor. K means clustering is applied for the image enhancement to the clear detection of tumor region. It converts the low resolution images to high resolution. Gradient profile is also included along with the k means clustering. Triangular model perform the further operations for tumor detection. Gradient profile sharpness proposed by this paper is based on the super resolution. These super resolution has three categories define in this paper are,

Interpolation approach, Learning and Reconstruction approach. Interpolation is a basic method under the super resolution. By using this approach it is possible to get the fast speed of whole processes. Learning approach is helpful to identify the detail about the loss of frequencies. Reconstruction approach provides consistency in images. After apply the gradient profile of image gradient profile sharpness is considered. The variance output of gradient profile is square root to get the results of sharpness. By using this proposed methodologies an exact location of tumor from the brain images has been find out. [25]

$$Jaccard = \frac{|P \cap Q|}{|P \cup Q|}$$

$$Dice = \frac{2|P \cap Q|}{|P| + |Q|}$$

Jose Dolz et al., (2018), they proposed the 3D FCNN for brain structure MRI segmentation. Mostly 3D FCNN is avoided because of their memory requirements and cost [26]. If we use the small kernels then we get the deeper architecture in CNN. This experiment is performed on publicly datasets. Datasets acquired in this paper from 17 sites into the age of 7-64 years patients. This methodology is robust in nature. 3D FCNN is very good technology for the segmentation which works through layers and kernels and give us accurate results. In FCNN architecture we can use the arbitrary size images. In this paper CNN follows the three convolutional layers and various filters. Output of previous CNN layer is input of the next layer. Pooling layer is a part of FCNN architecture which is used to decrease the resolution and parameters. FCNN has three types of architecture, CNN base, CNN single and CNN multi. [26]

A.Harshavardhan et al., proposed the pre processing, feature extraction and classification. Under pre processing stage there are some further operations of smoothing an image, skull stripping and filtering for the image enhancement also select the region of interest. Total 15 images of brain tumor are tested under this methodology. In the pre processing image is smoothed by apply the filtering on 2D input images. It helps to remove the noise of image. Next, skull boundaries from images are removed to the enhancement of the images. Filtering is very useful process for de-noising the brain image. In final stage ROI is defined by thresholding and by measure area of image, centroid, EQ diameter, perimeter and roundness. When results are obtained then image is merged with the binarization image. These methods give the accurate results with good execution time. [27]

K.Ezhilarasan et al., (2018), this paper presented the mean filtering and morphological operations to the automatic segmentation of T1-W brain MR images. The proposed methods are experimented above the five volumes T1-W normal MR images, which are taken from the IBSR. By take an input image from IBSR mean filtering is included to smooth an image. Then filtered image is binaries by selecting the threshold value. In Binarization process or erosion process some portion of the brain is shrunked. This shrunked portion of brain is recovered through dilation operation. For measuring the similarity of the results dice and jaccard algorithms are followed. Jaccard similarity average value is 0.936 and dice coefficient value is 0.965. These methods are applied with and without the mean filtered images so major difference is finding out in the end. [28]

Ujjwal Baid et al., (2017), presented the novel approach base on fuzzy clustering and non negative matrix (NMF) to the tumor detection. Total 80 patient's data is included to this research with HGG and LGG. NMF is a tool of the machine learning which helps to reduce the dimensionality. It has various applications also into the data mining. It clustered the data by extracting the features of an image. NMF is very good approach used in image segmentation. An image is dividing in several regions then the histogram of image is factorized by the NMF for each region. By anisotropic filtering technique pre processing is done of the input MR images. In NMF basic matrix (W) and coefficient matrix (H) helps to generate the data matrix (V). Fuzzy c-mean clustering segments the brain tumor into slices. By apply this proposed methodology to finding the accuracy of the segmentation is an essential task so dice and jaccard used to check the accuracy of segmentation. [29]

$$Dice = \frac{|P1 \wedge T1|}{(|P1| + |T|)/2}$$

$$Jaccard = \frac{|P1 \wedge T1|}{(|P1| \cup |T1|)}$$

$$Sensitivity = \frac{|P1 \wedge T1|}{|T1|}$$

$$Specificity = \frac{|P0 \wedge T0|}{|T0|}$$

Syad Muhammad Anwar et al. (2018) proposed a fully automatic algorithm of expectation maximization (EMAP) and k mean clustering to segment the LGG and HGG in MRI. For this research methodology no any training database is required. The proposed methodology starts from the pre processing of MRI scans then to perform the bias field correction 3D slicer is used. On the slices grey level normalization is done to normalize the input image. For segment the brain tumor posterior expectation maximization (MAP-EM) algorithm is performed. It is statistical technique which helps to find the maximum posterior parameters from the probabilistic models to the missed datasets. In this algorithm an image is divided in foreground and background regions. While pre processing is completed then k mean clustering is applied for extract the tumor regions. Dice parameters are included to measure the similarity of two samples of image and objects.[30]

Evgin Goceri et al. (2017), proposed the hybrid algorithms like anatomy knowledge, morphological processes, and Gaussian model (GMM) for extract the skull. Classification with the Gaussian mixture model finds skull location by using anatomy knowledge. Skull location from

left-right side of the image is formed by using the non-zero value in classification. After finding skull location mid point is calculated of image left and right hemisphere. At the end in post processing dilation and erosion operations are performed. [31]

Table of literature review which explain advantages of some proposed methodologies followed by various researchers:

S.No.	Ref. No.	Title of Paper	Author Name	Year	Advantages of proposed methods
1.	[2]	Brain Portion Extraction Scheme using Region Growing and Morphological Operation from MRI of Human Head Scans	K.Somasundaram,	2018	In region growing method each pixel is refer as a seed and grows along with the neighbouring pixels, there is no need of initial seed which has a costly selection process
2.	[6]	Rough K-Means and Morphological Operation-based brain tumor extraction	OyendrilaDobe	2019	Rough set k mean clustering cannot involves hard constraints, in which every pixel belongs to more than one cluster (advantage over traditional k mean clustering which contains hard constraints)
3.	[9]	Glioma Segmentation using a Novel Unified Algorithm in Multimodal MRI Images	Qingneng Li	2018	Proposed Fuzzy c mean clustering is fast methodology most widely used for segment the medical images
4.	[13]	Research on feature extraction of tumor image based on Convolutional Neural Network	Aimin Yang	2019	Novel approach of CNN cannot contains redundant input data because it divide an input image by super voxels (advantage over traditional CNN which take image directly as input, contains redundant data)
5.	[15]	New method of tumor extraction using a Histogram Study	Sandabad Sara	2015	Proposed histogram method of segmentation is very useful to understand image graphically and researchers also understand tonal distributions
6.	[29]	Novel Approach for Brain Tumor Segmentation with Non Negative Matrix Factorization	Ujjwal Baid	2017	Non negative matrix factorization (NNMF) is widely used because it helps to reduce dimensionality of data which is necessary to do segmentation in less time and accurately

3.8. CONCLUSION

This paper reviews on various existing techniques of brain MRI segmentation. In the literature survey different types of techniques are used for segment the brain MR image. By doing the thorough review, Authors can judge that there is no single method is too good to do the image segmentation because the outcomes or results are depends on the image quality, pixels, intensity value, accuracy etc. This paper concludes that we can't consider a single technique of segmentation to segment the all types of images in digital image processing; each and every technique has their pros, and cons. It's better to use the modified/hybrid method in future to segment the brain MRI to get the accurate results.

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