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Development of a Faster Region Based Convolution Neural Network technique for brain image classification

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***Abstract*—** In past decade, Tumor is one of the dangerous diseases in the world causing death of many people. MRI is one of the imaging technique which is widely used for tumor detection and classification. Also there are various methods for detection of brain tumor other than LIPC . Convolution neural network(CNN) is used in convolving a signal or an image with kernels to obtain feature maps. The image processing techniques such as equalized image, feature extraction and histogram equalization have been developed for extraction of the tumor in the MRI images of the cancer affected patients. Support Vector Machine(SVM) algorithm that works on structural risk minimization to classify the images. The SVM algorithm is applied to MRI images for the tumor extraction and a Simulink model is developed for the tumor classification function.

***Keywords*—** Brain tumor, CNN, Faster RCNN, classification, tumor detection

I. INTRODUCTION

Now days the MR Images are very useful in a Medical field like Medical image processing. The brain tumor defines the unusual growth of tissues and uncontrolled cells proliferation so due to this the natural pattern of cell growth and death is failed. The brain tumor is of two stages:-

1) Primary stage
2) Secondary stage

When tumor spread in any part of brain then it is known as brain tumor. Now when brain tumor can identified number of symptoms including seizures, mood changing, difficulty in walking and hearing, vision, and muscular movement etc. brain tumor is classified into Gliomas, medulloblastoma, epeldymomas, CNS lymphoma and oligodendrogloma. In primary stage the tumor can be removed but in secondary stage ,the tumor disease spread, due to this after removal of tumor the seldom remains and grow back again so this is the biggest problem in the secondary stage of tumor . Why this problem occurs? It occurs due to inaccurately location of area of tumor. The next step is detection techniques. In this the any segmentation and detection are to measure detection techniques the imaging of brain tumor can be done by1) MRI scanning that is magnetic resonant image 2) CT scanning i.e. computer tomography 3) Ultra sound etc. There are several method to detect an brain tumor by that the tumor method we can diagnose and detect more easily .some edges are nuclear network algorithm watershed and edge detection, fuzzy c mean algorithm, asymmetry of brain is used to detect an abnormality .

The problem of edge detection is the one of the most attractive problem for the image processing due to this it's various applications. Candy-edge detection is the one of the most useful feature in image segmentation. In this candy-edge detection is used for extraction of edges. F-transform is an intelligent method to handle uncertain information. This is useful for detection of tumor boundaries. It is very easy method for detection is a promising and efficient method for future and edge extraction progress.

II. CONVOLUTION NEURAL NETWORK

In deep learning, a convolutional neural network (CNN, or ConvNet) is a class of deep neural networks, most commonly applied to analyzing visual imagery. They are also known as shift invariant or space invariant artificial neural networks (SIANN), based on their shared-weights architecture and translation invariance characteristics.

CNNs are regularized versions of multilayer perceptrons. Multilayer perceptrons usually mean fully connected networks, that is, each neuron in one layer is connected to all neurons in the next layer. The "fully-connectedness" of these networks makes them prone to overfitting data. Typical ways of regularization include adding some form of magnitude measurement of weights to the loss function. CNNs take a different approach towards regularization: they take advantage of the hierarchical pattern in data and assemble more complex patterns using smaller and simpler patterns. Therefore, on the scale of connectedness and complexity, CNNs are on the lower extreme.

CNNs for segmentation can be categorized based on the dimension of convolutional kernel that is utilized. 2D CNNs use 2D convolutional kernels to predict the segmentation map for a single slice. Segmentation maps are predicted for a full volume by taking predictions one slice at a time. The 2D convolutional kernels are able to leverage context across the height and width of the slice to make predictions. However, because 2D CNNs take a single slice as input, they inherently fail to leverage context from adjacent slices. Voxel information from adjacent slices may be useful for the prediction of segmentation maps.

3D CNNs address this issue by using 3D convolutional kernels to make segmentation predictions for a volumetric patch of a scan. The ability to leverage interslice context can lead to improved performance but comes with a computational cost as a result of the increased number of parameters used by these CNNs.

III. BASIC METHODOLOGY

Image Acquisition: First considered that the MRI scan images of a given patient are either color, Gray-scale or intensity images herein are displayed with a default size of 220×220. If it is color image, a Gray-scale converted image is defined by using a large matrix whose entries are numerical values between 0 and 255, where 0 corresponds to black and 255 white for instance. Then the brain tumor detection of a given patient consist of two main stages namely, image segmentation and edge detection.

Pre-processing stage: Pre-processing stage consists of Noise removal this can be done by using various spatial filters linear or nonlinear filters (Median filter). Other artifacts like text removed by some morphological operations. RGB to grey conversion and reshaping also takes place here. It includes median filter for noise removal. The possibilities of arrival of noise in modern MRI scan are very less. It may arrived due to thermal Effect.

Image Smoothing: It is the action of simplifying an image while preserving important information. The goal is to reduce noise or useless details without introducing too much distortion so as to simplify subsequent analysis. Image Registration: Image registration is the process of bringing two or more images into spatial correspondence (aligning them). In the context of medical imaging, image registration allows for the concurrent use of images taken with different modalities (e.g. MRI and CT), at different times or with different patient positions. In surgery, for example, images are acquired before (preoperative), as well as during (intra-operative) surgery. Because of time constraints, the real-time intraoperative images have a lower resolution than the pre-operative images obtained before surgery. Moreover, deformations which occur naturally during surgery make it difficult to relate the highresolution pre-operative image to the lowresolution intra-operative anatomy of the patient. Image registration attempts to help the surgeon relate the two sets of images.

Image Segmentation: The segmentation is the most important stage for analysing image properly since it affects the accuracy of the subsequent steps. However, proper segmentation is difficult because of the great verities of the lesion shapes, sizes, and colors along with different skin types and textures. In addition, some lesions have irregular boundaries and in some cases there is smooth transition between the lesion and the skin. To address this problem, several algorithms have been proposed. They can be broadly classified as thresholding, edge-based or region-based, supervised and unsupervised classification techniques

Threshold segmentation
Water shed segmentation
Gradient Vector Flow (GVF)
K-mean Clustering
Fuzzy C-means Clustering

Morphological Operations: after segmentation morphological processing is applied to remove unwanted part. It consists of image opening, image closing, dilation, erosion operations. At the end the decision has taken weather that MRI image consists of any tumor or not and weather it normal or abnormal.

IV. RELATED WORK

Yuan, L.; et al. [1] utilized multiple convolutional layers to extract gradient information in different orientations and combines spatial information at two scales via the adding operation. High accuracy (over 92.5%) was obtained with a standard fivefold cross-validation strategy, demonstrating that the proposed method can effectively handle big data classifications from multiple centers. Compared with some traditional classification methods and some deep learning architectures, the proposed method was more accurate, demonstrating its stronger power to classify data from multiple centers. The cross-site classification results prove that the proposed method is robust when training on a data set and testing on another data set.

El-Dahshan, E.A.; et al. [2] presented a hybrid technique for the classification of the magnetic resonance images (MRI). The proposed hybrid technique consists of three stages, namely, feature extraction, dimensionality reduction, and classification. In the first stage, we have obtained the features related to MRI images using discrete wavelet transformation (DWT). In the second stage, the features of magnetic resonance images have been reduced, using principal component analysis (PCA), to the more essential features. In the classification stage, two classifiers have been developed. The first classifier based on feed forward back-propagation artificial neural network (FP-ANN) and the second classifier is based on k-nearest neighbor (k-NN). The classifiers have been used to classify subjects as normal or abnormal MRI human images.

Kumar, P.; and Kumar B.V.; [3] proposed an algorithm that was consisted of manifold phases. Preprocessing, segmentation, feature extraction, and classification. At initially preprocessing is performed by using filtering algorithm. Secondly segmentation is performed by using clustering algorithm. Thirdly feature extraction is performed by Gray Level Co-Occurrence Matrix (GLCM). Automatic brain tumor stage is performed by using ensemble classification. This phase classifies brain images into tumor and non-tumors using Feed Forwarded Artificial neural network based classifier. Experiments have exposed that the method was more robust to initialization, faster and accurate.

Kaur, R.; and Doegar, A.; [4] discussed the different techniques that are used for tumor pre-processing, segmentation, localization, extraction of features and classification and summarize more than 30 contributions to this field and also discussed the existing state-of-the-art, literature gaps, open challenges and future scope in this area. Digital image processing is a rising field for the investigation of complicated diseases such as brain tumor, breast cancer, kidney stones, lung cancer, ovarian cancer, and cervix cancer and so on. The recognition of the brain tumor is considered to be a very critical task. A number of approaches are used for the scanning of a particular body part like CT scan, X-rays, and Magnetic Resonance Image (MRI). These pictures are then examined by the surgeons for the removal of the problem. The main objective of examining these MRI images (mainly) is to extract the meaningful information with high accuracy

Bansal, S.; et al. [5] worked on interference method, feature extraction, morphological operators, edge detection methods of gray level and Swarm Ant Lion Optimization based on brain tumor shape growing segmentation to optimize the image complexity and enhance the performance. In new algorithm implemented an inspiring nature method for segmentation of brain tumor image using hybridization of PSOA and ALO is also called a Swarm Ant Lion method. Evaluate the performance metrics with image quality factor (PSNR), Error Rate (MSE), and Exact value (Accuracy Rate). In research work, improve the performance metrics with PSNR and Accuracy Rate and reduce the error rates and compared with the existing method (PNN).

Kumar, S.; et al. [6] carried out brain tumor from MR Images with the help of hybrid approach. This hybrid approach includes discrete wavelet transform (DWT) to be used for extraction of features, Genetic algorithm for diminishing the number of features and support vector machine (SVM) for brain tumor classification. Images are downloaded from SICAS Medical Image Repository which classified images as benign or malign type. The proposed hybrid approach is implemented in MATLAB 2015a platform. Parameters used for analyzing the images are given as: entropy, smoothness, root mean square error (RMS), kurtosis and correlation. The simulation analysis approach results shows that hybrid approach offers better performance by improving accuracy and minimizing the RMS error in comparison with the state-of-the-art techniques in the similar context.

Dharnia, S.; and Wasson, V. [7] presented a fully automated method for an automated brain-tumour boundary detection using region based segmentation technique along with SVM Classifier of Magnetic Resonance Imaging (MRI). The procedure is based on artificial intelligence technique and classification of each super-pixel in MRI. A number of novel image features extraction approaches including intensity-based, texture based, fractal analysis and curvatures are calculated from each super-pixel within the entire brain area in MRI to ensure a robust classification. Brain tumor is the malignant types of cancer and their classification in earlier stage is biggest issue. While curable with early classification is useful, only extremely trained specialists are capable of accurately recognizing the cancer from skin MRI data. As expertise is in limited contribute, an automated systems capable of classifying cancer could save human lives, and also help to reduce unnecessary MRI, and reduce extra costs. On the way to achieve this goal, we proposed a Brain Tumour Detection and Classification System (BTDCS) that combines recent developments in machine learning with Support Vector Machine (SVM) structure, creating hybrid algorithm of threshold based segmentation with Maximally Stable External Regions (MSER) that are capable of segmenting accurate super-pixel region from MRI, as well as analyzing the detected area and surrounding tissue for malignant.

Balakumar, B.; et al. [8] trained the self-organizing map neural network trains the features extracted from the discrete wavelet transform blend wavelets and the resultant filter factors are consequently by the K-nearest neighbour and the testing process is also accomplished in two stages. The proposed two-tier classification system classifies the brain tumors in double training process which gives preferable performance over the traditional classification method. The classifiers can accurately classifying the status of the brain image into normal / abnormal.

Parveen and Singh, A.; [9], proposed data mining methods for classification of MRI images. Classification isperformed in four stages: pre-processing, segmentation, feature extraction, and classification. In the first stage,enhancement and skull stripping is performed to improve the speed and accuracy. Segmentation was done by Fuzzy CMean (FCM) clustering. Grey level run length matrix (GLRLM) is used for extraction of feature from the brain image, after which SVM technique is applied to classify the brain MRI images, which provide accurate and more effective result for classification of brain MRI images.

Akakin, H.C. et al.; [9] propped the system for multi image queries. Feature is extracted in two part; For Color

extraction they have used the color spaces are CIELab (Lab) and hue–saturation–value (HSV) color spaces additional to RGB. The total 26 color and gray-scale features are extracted using three different color spaces for a given image. Texture feature is extracted using Co-occurrence histograms. They have used the two separate classifier (SVM and k-NN) for the classifications of images. They have achieved about 93% and 86% average classification accuracy.

Guruvasuki, R.; Pushpa, A.J.; [10]have designed the method using multi support vector machine classifier. The image is preprocessed with median filter. The Gray Level Cooccurrence Matrix is used for feature extraction. Multi Support Vector Machine (M-SVM) classifier is used for classification of three types of image. System performance is improved by the multiple image queries than single image query.

Mohanapriya.S, Vadivel.M [11] propose a robust retrieval using a supervised classifier which concentrates on extracted features. Gray level co-occurrence matrix algorithm is implemented to extract the texture features from images. The feature optimization is done on the extracted features to select best features out of it to train the classifier. The classification is performed on the dataset and it is classified into three categories such as normal, benign and malignant. They have used the SVM (Support Vector machine) classifier followed by KNN (K-nearest neighbor). B.Ramasubramanian,

Prabhakar, G.;Murugeswari, S.; [12] designed the Multitier system for microscopic images having more than one disease. The features based on colour and texture is extracted. In the first tier, the images are classified by recursive SVM classifier with the help of extracted features. In the next tier, the similar images are retrieved using Decision tree algorithm. They have achieved the accuracy 96% (for FL) and 98% (for NB).

Zhang, Y. Et al.; [13] have developed a novel hybrid classifier to distinguish normal and abnormal brain MRIs. In this paper, they present a neural network (NN) based method to classify a given MR brain image as normal or abnormal. This method first employs wavelet transform to extract features from images, and then applies the technique of principle component analysis (PCA) to reduce the dimensions of features. The reduced features are sent to a back propagation (BP) NN, with which scaled conjugate gradient (SCG) is adopted to find the optimal weights of the NN.

Kalbkhania, H. Et al.; [14] have proposed method which can classifies MRI into normal or one of the seven different diseases. The coefficients of two-level 2D DWT of brain MRI are computed. The calculated coefficients of detail sub-bands are modeled by GARCH. After feature vector normalization, principal component analysis (PCA) and linear discriminant analysis (LDA) are used to extract the proper features and remove the redundancy from the primary feature vector. Finally, the extracted features are applied to the Knearestneighbor (KNN) and support vector machine (SVM) classifiers separately to determine the normal image or disease type.

Chaplot, S.; et al. [15] propose a novel method using wavelets as input to neural network self-organizing maps and support vector machine for classification of magnetic resonance (MR) images. In this paper, they have used the wavelets as input to support vector machine and neural network. Classification accuracy of more than 94% was achieved using the neural network self-organizing maps (SOM) and 98% from support vector machine.

Iscan, Z. Et al.; [16] proposed method for the detection of tumor in magnetic resonance (MR) brain images. First 2D continuous wavelet transform (CWT) and then each MR image is segmented into seven classes (six head tissues and the background) by using the incremental supervised neural network (ISNN). Symmetry axis of the head is determined by using moment properties. Asymmetry is analyzed using the Zernike moments of each of six tissues. The two vectors are individually formed for the left and right hand sides of the symmetry axis. The two vectors are used to determine the asymmetry and tissue with the tumor.

Furao, S. et al.; [17] proposed an enhanced self-organizing incremental neural network (ESOINN), which is based on SOINN. The proposed method can realize all SOINN functions. Using singlelayer network to take the place of two-layer network structure of SOINN, ESOINN can realize pure online incremental learning. By setting conditions for building a connection between nodes, ESOINN can separate high density overlapped classes. In fact, ESOINN only adopts between-class insertion to realize incremental learning.

Jain, M.; et al. [18] had proposed strategy for detection of tumor with the help of segmentation techniques in MATLAB; which incorporates preprocessing stages of noise removal, image enhancement and edge detection. Processing stages includes segmentation. Tumor region is extracted using over global thresholding method. Post proposing stage include histogram clustering, morphological operations. In this step the shape of tumor is determine and also area is calculated. R. **Kumar, S.R.; and Niranjana, G.; [20]** proposes segmentation using cellular automata and classification of tumors using Gray level Co-occurrence matrix features and artificial neural network. Seed pixel selection is done by using the GLCM and after selection by calculating the run length it is checked that the seed pixel is belong to abnormal region or not. The segmentation using cellular automata done and then classification done using Radial basis function which is the type of ANN. The approach is limited by the fact that it necessitates fresh training each time whenever there is a change in image database.

Machhale, K.; et al. [21] presented an intellectual classification system to recognize normal and abnormal MRI brain images. For preprocessing Median filter and morphological operations are used. In feature extraction phase, gray scale, symmetrical and texture features are extracted. They have used the three classifier; Support Vector Machine (SVM), K- Nearest Neighbor (KNN) and Hybrid Classifier (SVMKNN). They used these classifiers to classify 50 images. The result observation shows that the Hybrid classifier SVMKNN demonstrated the highest classification accuracy rate of 98% among others.

Gopal, P.N.; Sukanesh, R.; [22] in their paper they presented a combination of wavelet statistical features (WST) and wavelet co-occurrence texture feature (WCT) obtained from two level discrete wavelet transform (DWT). is used for the classification of abnormal brain tissues in to benign and malignant. The proposed system consists of four phases: segmentation of region of interest, discrete wavelet decomposition, feature extraction and feature selection and classification and evaluation. The support vector machine is employed to segment the shape of tumor information. A combination of both WST and WCT texture features is extracted from tumor region of two-level discrete wavelet transformed images. Genetic algorithm (GA) is used to select the optimal texture features from the set of extracted features. The probabilistic neural network classifier (PNN) is built to classify the abnormal brain tissues into benign, malignant tumor images. Comparing the classifications results of PNN, LVQ, BPN classifiers for the texture analysis methods, the results shows that best performence3 is achieved by PNN. The 97.5% accuracy is achieved.

Sinha, K.; and Sinha, G.R.; [23] presented a comparative study of three segmentation methods implemented for extraction of tumor in the MRI images. The methods include kmeans clustering with watershed segmentation algorithm, optimized k-means clustering with genetic algorithm and optimized c- means clustering with genetic algorithm. Using all three methods exact position and the shape are determined. Results shows that genetic c-means algorithm provide fast and efficient clustering results and also eliminate the over segmentation problem.

Balaji, P.; et al. [24] proposed brain tumor detection method for MRI images. In this paper, the brain tumor is detected & classified stages of the tumor by using testing & training the database. Proposed methodology consists of following main stages: image preprocessing, de noising, SWT & segmentation, feature extraction an classification. In the first step, median based filters and SWT technique are used for de-noising the image. Then spatial FCM technique is used for segmentation and Stationary wavelet transform (SWT) technique is used for feature extraction, as SWT coefficients will not change even if the signal is shifted. In the last step, using Probabilistic neural networks (PNN) images are classified with the help of extracted features.

Table 1

Year	Title	Contribution
2018	Multi-Center Brain Imaging Classification Using a Novel 3D CNN Approach	utilized multiple convolutional layers to extract gradient information in different orientations and combines spatial information at two scales via the adding operation. High accuracy (over 92.5%) was obtained with a standard fivefold cross-validation strategy, demonstrating that the proposed method can effectively handle big data classifications from multiple centers.
2010	Hybrid intelligent techniques for MRI brain images classification	presented a hybrid technique for the classification of the magnetic resonance images (MRI). The proposed hybrid technique consists of three stages, namely, feature extraction, dimensionality reduction, and classification.
2019	Brain Tumor MRI Segmentation and Classification Using Ensemble Classifier	proposed an algorithm that was consisted of manifold phases. Preprocessing, segmentation, feature extraction, and classification. At initially preprocessing is performed by using filtering algorithm.
2019	Localization and Classification of Brain Tumor using Machine Learning & Deep Learning Techniques	discussed the different techniques that are used for tumor pre-processing, segmentation, localization, extraction of features and classification and summarize more than 30 contributions to this field and also discussed the existing state-of-the-art, literature gaps, open challenges and future scope in this area.
2019	Enhancement in Brain Image Segmentation using Swarm Ant Lion Algorithm	worked on interference method, feature extraction, morphological operators, edge detection methods of gray level and Swarm Ant Lion Optimization based on brain tumor shape growing segmentation to optimize the image complexity and enhance the performance.
2017	Classification of Brain MRI Tumor Images: A Hybrid Approach	carried out brain tumor from MR Images with the help of hybrid approach. This hybrid approach includes discrete wavelet transform (DWT) to be used for extraction of features, Genetic algorithm for diminishing the number of features and support vector machine (SVM) for brain tumor classification.
2019	An Automated Brain Tumour Boundary Detection using Region based Segmentation Technique along with SVM	presented a fully automated method for an automated brain-tumour boundary detection using region based segmentation technique along with SVM Classifier of Magnetic Resonance Imaging (MRI).

	Classifier	
2017	Brain Tumor Classification Using Machine Learning Algorithms	trained the self-organizing map neural network trains the features extracted from the discrete wavelet transform blend wavelets and the resultant filter factors are consequently by the K-nearest neighbour and the testing process is also accomplished in two stages.

V. TECHNIQUES

The purposes of this study an automated detection and segmentation techniques for the extraction of brain tumor region and separation of tumor on the MR image. This MR image helps to overcome the time taking process of manual segmentation of large datasets.

Fuzzy based methods Fuzzy logic is a set of mathematical principles for knowledge representation based on degrees of classical binary logic. In brain tumor segmentation fuzzy systems allow for the development of methods to perform the tasks related to intelligent human behaviours. Dunn suggested image segmentation using fuzzy c-means (FCM) clustering algorithm. FCM implementated by many researchers and provide improved version for segmentation for brain MRI.

FCM algorithm fails to deal with significant properties of images, which leads to strong noise sensitivity. To overcome this weakness, proposed a new clustering algorithm named PCM. possibilistic membership, are very sensitive to the choice of the additional parameters of PCM, which directly decide the clustering accuracy.

Thresholding based Methods In thresholding approach image segmentation is based on gray level intensity value of pixels. Thresholding procedure determining a intensity value which breaks the desired sections. Then segmentation achieved by grouping pixels greater intensity into one single section of threshold and all other pixels into another section.

The level set method used as numerical technique for tracking interfaces and shapes has been increasingly applied to image segmentation in past decade. Contour based level set method represents as the zero level set of a higher dimensional function, is called a level set function. In the level set representation, the image segmentation problem can be solved and formulated by well established mathematical theories, including calculus of variation and partial differential equations (PDE). Also represent contours/surfaces with complex topology. Level set method segmentation can be categorized into two classes: region based model and edge based models.

Region Growing based Methods Region growing is the simplest region-based segmentation that groups pixels or sub-region into larger regions based on pre-defined criteria. The pixel aggregation starts with a set of seed points in a way that the corresponding regions grow by appending to each seed points those neighbouring pixels that similar properties Such as:
Gray level
Texture
Color
Shape

Region growing is not often used alone because it is not sufficient to segment brain structures accurately and robustly. Pohle suggested that region growing can be an integrated technique using multi-level sets of boundary information [9]. As compared to edge detection method, segmentation algorithms based on region are very simple and strongly immune to noise.

Clustering based Methods Cluster analysis or clustering is the task of grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups.

The simplest and most commonly used algorithm, employing a squared error criterion is the K-means algorithm. K-mean is one of the simplest unsupervised learning algorithms that solve the well known clustering problem. The K-mean clustering is a popular approach to partition d- dimensional data into K clusters such that an objective function providing the desired properties of the distribution of feature vectors of clusters in terms of similarity and distance measures is optimized. A generalized K-mean clustering algorithm initially places K clusters at arbitrarily selected cluster centroids vi = 1, 2…k and modifies centroids for the formation of new cluster shapes optimizing the objective function. The K-means clustering method optimizes the sumof squared- error-based objective function.

VI. CONCLUSION AND FUTURE SCOPE

This survey mainly focuses on the study of brain tumor segmentation on MR images. a simple and effective algorithm for automatic tissue classification. The method has been applied to the segmentation of MR brain structures with intensity inhomgeneities and noise. Among all methods discussed for MR brain. A segmentation technique is more effective, more robust for different level of noise, less iteration steps and more accurate for both 2D and 3D brain MR image segmentation. Moreover, for good initialization thereby allowing fully automated application. In the future the accuracy and recognition of the abnormality can be detected using then RCNN method in a more efficient way.

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