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Brain Tumor Detection and Classification using Image Processing and Machine Learning

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Abstract

Brain Tumor detection is one of the most critical and arduous tasks in the area of medical image processing. Image Processing is a technique to extract the important features as well as to enhance the images received from the camera, satellite, or taken in day to day life for various applications.
It is an imperative aspect of medical science to visualize the internal structures of brain as well as to diagnosis, monitor and treat disease. Several types of imaging technologies like CT-scan and MRI, X-ray is used in medical field to diagnose the human part of body. MRI is used to diagnosis or locating tumor in brain, measuring tissue volume, estimate tumor size. Detection of tumor from brain is very difficult due to variance and complexity of tumor and dense brain tissues. Different image processing techniques and machine learning techniques is used for detection and classification of Brain Tumor. In this paper we are going to show the comparisons of different techniques to Diagnosis of Brain Tumor.

Keywords- *Medical Images, MRI, Segmentation, Brain Tumor, Classifications.*

Introduction

Brain tumors arise due to uncontrolled and excessive cell growth brain. Brain tumor classified into primary and secondary tumors. Image processing is the study of any algorithm that takes an image as input and returns an image as output. The ultimate goal of the image processing application is to extract important features from the image. It includes image display and printing, image editing and manipulation, image enhancement, feature detection, image compression, image segmentation, image registration. There are vast application area of image processing like in bio-medical, forensics, remote sensing, agriculture, food control, automobiles and communications. Nowadays image processing is one of the most emerging research areas for medical image processing. The MRI images have constraints like noise, clarity of images. Noise is unwanted information present in images. Sometimes noise if effect to the edges and fine details which limit the contrast resolution. Due to Nosie it becomes difficult to determine the exact boundaries and classified the tumor which make it an emerging area of research in image processing. In this paper, we compare an effective and skillful method which helps in the segmentation, detection and classification of the brain tumor.

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List of abbreviation:

SVM	Support Vector Machine	GA	Genetic Algorithm
MRI	Magnetic Resonance Images	NN	Neural Network
CNN	Convolutional neural network	ANN	Artificial neural network
PSNR	Peak signal-to-noise ratio	RGB	Red Green Blue

General methodology to detection and classification of brain tumor

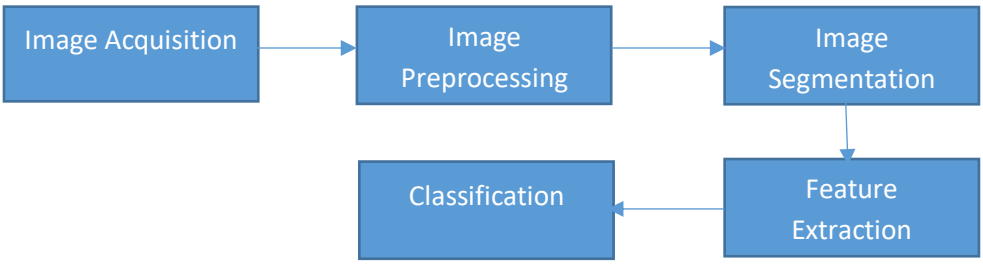

Figure 1

Literature Review

G. Hemanth [ICOEI 2019] proposed a Machine Learning Approach for automatic detection of Brain Tumor. There are six stages in proposed method. 1. Data Collection 2. Pre-Processing 3. Average filtering 4. Segmentation 5. Feature Extraction 6. Classification. CNN (Convolutional Neural Network) is used for classification and identification of tumor in proposed methodology. To eliminate the noisy data from images, pre-processing steps have been performed. To achieve clarity in images, Average filtering technique is used. Then pixel based segmentation method is used to detect a brain image and other affected area. Features like PSNR, MEAN, Entropy and Standard deviation were extracted from the segmented image and then classification using extracted features is done using CNN. Parameters like Root Mean Square Error, recall, sensitivity, Probability of misclassification error and accuracy of training and testing calculated to evaluate the performance of proposed methods. The proposed method achieved classification accuracy 91% and Efficiency 92.7%.T. Chithambaram [ICPCSI-2017] suggested techniques for segmentation of Brain Tumor using Genetic Algorithm and Artificial Neural Network. There are two datasets have been used. First dataset contains 350 post contrast T1 – weighted Magnetic Resonance (MR) images of 30 patients and Second dataset contains 280 post contrast T1- weighted MR images of 30 patients. This paper mainly based on classification of primary tumors (originate in the brain itself) and secondary tumors (cancer cells originate from other parts of body). Magnetic Resonance images which provides texture and intensity information of brain tumor were taken as an input. There are 4 modules in the proposed method. To detect a portion of tumor, Content based active contour module is proposed. After then tumor regions has been saved as segmented regions of interest and features based on intensity and texture were extracted from it. To select a set of salient features from input features, Genetic Algorithm is used. Two hybrid machine learning models are implemented using GA with SVM and ANN. Overall 90% accuracy is achieved using proposed methodology. GA-SVM is proposed for finding preliminary probability in

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identifying tumor class and GA-ANN is use for confirmation of accuracy.Astina Minz [IACC 2017] has proposed a method to classify brain tumors from MR images using adaboost algorithm of Machine Learning. There are four stages in proposed system. 1. Pre – processing 2. Segmentation 3. Feature Extraction and 4. Classification. Pre-processing steps cooverts RGB to greyscale conversion, and to eliminate noise from image, median filter is used. Then using thresholding technique, useful part from image is selected. Then GLCM algorithm is used to extract texture features like Energy, Contrast, Correlation homogeneity etc. from segmented images. Then adaboost algorithm is used to classification of brain tumors in malignant and benign category. Classification accuracy achieved with proposed method is 89.90%.F.P. Polly [2018] has proposed a method to detect and classify HGG (High Grade Glioma) and LGG (Low Grade Glioma) brain tumor using Machine Learning. The purpose of the research was to differentiate between normal and abnormal brain tumor and further classification of abnormal brain tumor into HGG and LGG tumors. In the proposed method, otsu binarization is applied to covert input image to binary image. After then segmentation of tumor is done by k-means clustering method. Discrete Wavelet Transform is used to extract features and Principal Component Analysis is used for feature reduction. SVM is used to classify tumors in stage-1 as well as stage-2. Classification accuracy achieved with proposed method is 99%.

Shankaragowda B. [2017] has proposed a method for detection and classification of brain tumor using Support Vector Machine. In this research, main focus was on to classify tumors into malignant and benign tumors. In the proposed method includes pre-processing, segmentation, feature extraction and classification stages. In pre-processing stage, new pixel brightness is calculated using: Pixel brightness transform and Geometric transform. Thresholding techniques, color based segmentation methods and texture methods are used to detect tumor. Then SVM is used to classify the tumor based on extracted features into malignant and benign tumors.Ravindra Sonavane [ICSSS 2017] has proposed a method to classify brain tumor using MRI and Mammogram Images using Learning Vector Quantization Neural Network. The proposed method works on two databases: Clinical database (MRI) and Standard Digital Database (Mammogram Images). There are there stages in proposed method. 1. Pre-processing 2. Feature Extraction and 3. Classification. Image normalization and morphological operations are performed to extract brain part from image. Then Anisotropic Diffusion Filter is used for noise reduction as well as enhances the image quality with good resolution. Grey level co-occurrence metrics technique is used to extract features and classification into normal and abnormal tumors using machine learning algorithm and LVQ method. The classification accuracy is achieved 68.85% for mammography database and 79.35% for clinical database.K. Sudharani [ICCICCT 2015] has proposed a method to identify and classify brain tumor from MRI using kNN. In the proposed method, histogram of the image is generated which shows distribution of pixel in image. Then input image is resampled to 629*839. kNN classifier is used to classify brain tumor and distance between neighbours has been calculated by Euclidian distance, Manhattan distance and Maximum distance. The classification accuracy is 95% for MR images.Neelum Noreen [2020] has proposed a multilevel features extraction and concatenation approach for the diagnosis of tumor using deep learning. There are two pre-trained models proposed. First is Inception-v3 and second is DensNet201. These models are used to evaluate two different scenarios of brain tumor detection and classification. In the proposed method, the pre-trained Inception-v3 model is used extract features from different Inception modules and concatenate them and used them as an input to softmax classifier to classify the brain tumors. Then pre-trained DensNet201 model is used to extract features from different DensNet blocks and concatenate them and

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used as an input to softmax classifier. The classification accuracy of proposed model with respect to Inception-v3 and DensNet201is 99.34% and 99.51%.

Zuliani Zulkoffli [2019] has proposed a method for brain tumor detection and extraction of features from MR Images using k-means clustering and morphological operations. In the proposed method, first images were converted to grayscale and to remove noise from it median filter is used. To separate the image into clusters with different intensity levels, k-means clustering algorithm is used. Morphological operations applied to extract the tumor from the cluster. Features like vitality, differentiate, kurtosis, relationship and homogeneity are found alongside the zone and border of the tumor and the accuracy of the extraction. These separated features can be utilized later on to all the more precisely classify brain tumors with the assistance of neural network. The proposed method achieved classification accuracy 91.65%.M.H.O Rashid has proposed a method to detect brain tumor from MR Images using Anisotropic Filtering, Morphological operations and SVM. In the proposed method, Anisotropic Filtering is used to remove noise from input images. Segmentation of tumor from filtered images is done by SVM. SVM classifies pixel in to two classes. Then location of the tumor was extracted from segmented area using morphological operations. The proposed method achieved accuracy 83% for tumor detection.

Reema Mathew [2017] A has proposed a method to detect and classify a brain tumor using Wavelet Transform and SVM. In the proposed method, Otsu's thresholding algorithm is used to detect tumor by setting proper threshold value and Anisotropic diffusion filter is used to remove noise and increase resolution of an image. Then to detect location of the tumor , morphological operations are performed. Then Discrete Wavelet Transform is applied to extract features from segmented image. These features were given as an inout to SVM classifier to classify brain tumors into malignant and benign. The proposed method achieved accuracy 86% for brain tumor classification.Mircea Gurbina [2019] has proposed a method to detect brain tumer from MR images using Wavelet transform and SVM. In the proposed method, wavelet based thresholding techniques are used to remove noise from the image. Otsu's thresholding algorithm is used to detect object from the image. Different wavelet transforms are used to extract features and reduction in dimensionality of predictor space, principal component analysis algorithm is used. Then, the selected features were applied to SVM Classifier to classify tumor into malignant and benign category.

Sr. No	Author	Segmentation	Classifier	Accuracy
1	NeelumNoreen [2020]	Not given	Softmax	99.51%
2	Mircea [2019]	Otsu's method	SVM	99%
3	F.P. Polly [2018]	k-means clustering	SVM	99%
4	K.Sudharani [2015]	Histogram and Resampling	KNN	95%
5	Zuliani Zulkoffli [2019]	k-means and morphological operations	Neural Network	91.65%
6	G.Hemanth [2019]	Pixel based segmentation	CNN	91%
7	T. Chithambaram [2017]	Content based active contour	GA – SVM & GA-ANN	90%
8	Astina Minz [2017]	Threshold	Adaboost	89.90%

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9	Reema Mathew [2017]	Morphological operations	SVM	86%
10	M.H.O Rashid	SVM	Not given	83%
11	Shankaragowda B. [2017]	Threshold, color based segmentation and Texture method	SVM	Not-available
12	Ravindra Sonavane [2017]	Image normalization and morphological operations	Learning Vector Quantization ,Neural Network	Mammography Database: 68.85%,Clinical database (MRI) 79.35%

Table 1 Comparisons of Segmentation and Classifications techniques for brain tumor detection

Conclusion:

The review paper consist of different methods for identification and classification of brain tumors using dataset of Magnetic Resonance Images and Mammography Images. Biggest challenge is to detect object from complex background. In this research, there is no commonly accepted methods for Image segmentation and classification. All the above mentioned methods are relatively good for specific category of image. In this paper, different pre-processing, image segmentation, feature extraction and classification methods are summarized and presented. Initially, input image is passed through pre-processing steps in which noise reduction and image smoothing is performed. Anisotropic diffusion filter has more advantages. It is used for noise reduction as well as enhance image quality with good resolution. After then image is segmented using different thresholding and clustering methods. Final analysis is based on extracting features using Genetic algorithm to discrete wavelet transform. From segmented images, the extracted features can be further classified using classifier. Based on analysis of different methods mentioned in this paper, the result achieved with good accuracy through SVM classifier. Amongst all these methods many reached good results with an accuracy. In the future, approaches and ideas which are proven to work well from methods which were already proposed can be extracted, combined and further improved.

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