International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 4, July-Aug-2020, ISSN (Online): 2395-566X

A Review on Brain Tumor Segmentation and Classification Using Machine Learning Technique

Nayan Pure
M.Tech Scholar
Dept. of CSE
Vindhya Institute of Technology & Science
Indore (M.P)
nayanpure09@gmail.com

Ashish Tiwari
Assistant Professor & Head
Dept. of CSE
Vindhya Institute of Technology & Science
Indore (M.P)
ashishtiwari205@gmail.com

***Abstract* – The successful early diagnosis of brain tumors plays a major role in improving the treatment outcomes and thus improving patient survival. Manually evaluating the numerous magnetic resonance imaging (MRI) images produced routinely in the clinic is a difficult process. Thus, there is a crucial need for computer-aided methods with better accuracy for early tumor diagnosis. Computer-aided brain tumor diagnosis from MRI images consists of tumor detection, segmentation, and classification processes. Over the past few years, many studies have focused on traditional or classical machine learning techniques for brain tumor diagnosis. Recently, interest has developed in using deep learning techniques for diagnosing brain tumors with better accuracy and robustness. these detection and segmentation approaches are reviewed with an importance placed on enlightening the advantages and drawbacks of these methods for brain tumor detection and segmentation. The use of MRI image detection and segmentation in different procedures are also described. Here a brief review of different segmentation for detection of brain tumor from MRI of brain has been discussed.**

***Keywords*– brain tumor, MRI, SVM, Feature extraction, machine learning**

I. INTRODUCTION

Magnetic resonance imaging of brain image computing has very increased field of medicine by providing some different methods to extract and visualize information from medical data, acquired using various acquisition modalities. Brain tumor segmentation is a significant process to extract information from complex MRI of brain images. Diagnostic imaging is a very useful tool in medical today. Magnetic resonance imaging (MRI), computed tomography (CT), digital mammography, and other imaging processes give an efficient means for N detecting different type of diseases.

The automated detection methodology have deeply improved knowledge of normal and diseased examination for medical research and are a important part in diagnosis and treatment planning when the number of patients increases[1]. Segmentation has spacious application in medical imaging field such as MRI of brain, MRI of human knee, etc. for analyzing MRI of brain, anatomical structures such as bones, muscles blood vessels, tissue types, pathological regions such as cancer, multiple sclerosis lesions and for dividing an entire image into sub regions such as the white matter (WM), gray matter (GM) and cerebrospinal fluid (CSF) spaces of the brain automated delineation of different image components are used. Thus in the field of MRI of brain tumor segmentation from brain image is significant as MRI is particularly suitable for brain studies because of its excellent contrast of soft issues, non invasive

characteristic and a high spatial resolution. Brain tumor segmentation partitions a portion into mutually special and pooped regions such that each region of interest is spatially contiguous and the pixels within the region are homogeneous with respect to a predefined criterion. Mostly, homogeneity conditions include values of concentration, texture, color, range, surface normal and surface curvatures. Through past many researchers have prepared important research in the field of brain tumor segmentation but still now it is very important research fields.

Medical history, biopsy–whereby a small amount of brain tissue is excised and analyzed under the microscope–and imaging studies are all important to reach a diagnosis of brain tumor. Standard x-rays and computed tomography (CT) can initially be used in the diagnostic process. However, MRI is generally more useful because it provides more detailed information about tumor type, position and size. For this reason, MRI is the imaging study of choice for the diagnostic work up and, thereafter, for surgery and monitoring treatment outcomes [2]. Thus

here short introduction with MRI, brain tumor and automated system also discussed.

Rest of the part organized as follows: Section 2 describes the Magnetic resonance imaging of Brain Image. In Section 3 there is a description about Brain Tumor. Section 4 describes the automated system and Section 5 consists of Preprocessing. Colour Fundamentals is described in Section 6 and Section 7 consists of Segmentation. In Section 8 there are Summery and Conclusion. Section 9 consists of Reference[2][3]

Magnetic resonance imaging (MRI):A magnetic resonance imaging instrument or MRI Scanner [3][6] uses powerful magnets to polarize and excite hydrogen nuclei i.e. proton in water molecules in human tissue, producing a detectable signal which is spatially encoded, resulting in images of the body [4].[7]MRI mainly uses three electromagnetic fields they are : i) A very strong static magnetic field to polarize the hydrogen nuclei, named as the static field, ii) A weaker time varying field(s) for spatial encoding, named as the gradient field, iii) A weak radio frequency field for manipulation of hydrogen nuclei to produce measurable signals collected through RF antenna. The variable behaviour of protons within different tissues leads to differences in tissue appearance.

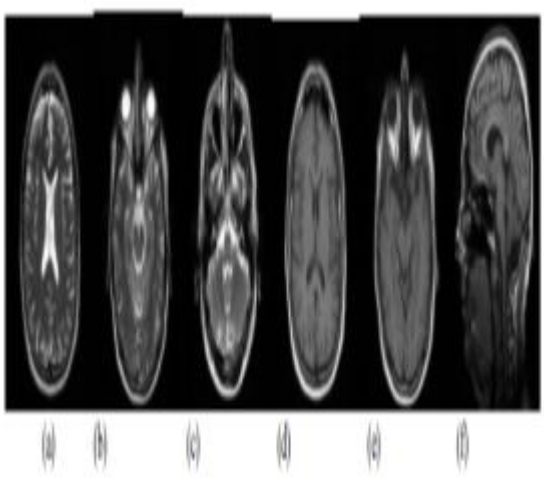

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Fig.1. MRI of brain.

T2 weighted MR image (a) brain shows cortex, lateral ventricle, and falxcerebri, (b) brain shows eyeballs with optic nerve, medulla, vermis, and temporal lobes with hippocampal regions, (c) head shows maxillary sinus, nasal septum, clivus, inner ear, medulla, and cerebellum. T1 weighted MR image (d) brain shows cortex, white and grey matter, third and lateral venticles, putamen, frontal sinus and superior sagittal sinus, (e) brain shows eyeballs with optic nerve, medulla, vermis, and temporal lobes with hippocampal regions,(f) brain shows cortex with white and grey matter, corpus callosum, lateral ventricle, thalamus, pons and cerebellum from the same patients.

Fig. 1 shows the bimodal histogram of an image f(x, y) with threshold as T. MR Imaging (MRI) Magnetic Resonance Imaging (MRI) is a non invasive method and can be used safely as often as necessary for brain imaging. MRI images are used to produce detailed and accurate pictures of human organs from different angles for diagnosing abnormalities. There are two types of MRI high field for producing high quality images and low field MRI for smallest diagnosis condition [15[11]]. MRI images can be used by physicians for visualizing even hair line cracks and tears in injuries to muscles, ligaments and other soft tissues.

The main principle of MRI is based on the absorption and emission of energy in radio free range of electron magnetic spectrum. Magnetic resonance imaging (MRI) is excellent for showing abnormalities of the brain such as tumor, multiple sclerosis or lesions, stroke, haemorrhage. Fig.1 shows an MRI image of brain tumor. Accurate anatomical three-dimensional (3D) models derived from 2D MRI medical image data helps in providing accurate and precise diagnostic information about spatial relationships between critical anatomical structures such as vascular structures, eloquent cortical areas, etc and other pathological findings which otherwise were indistinguishable by the naked eye (X. Hu et.al 1990).

MRI is commonly used for brain tumor imaging because of the following reasons: i. It does not use any ionizing radiations like CT, SPECT and PET. ii. Its contrast resolution is higher than above mentioned techniques. iii. Ability of MRI devices to generate 3D space images enables them to have superior tumor localization. iv. Its ability in acquisition of both anatomical and functional information about the tumor during the same scan. Segmentation is the process of dividing or partitioning an image into several segments. The main difficulties in the process of segmentation [8] are: a. Noise b. The bias field (the presence of smoothly varying intensities within tissues) c. The partial-volume effect (a voxel contributes in multiple tissue types).

Image Segmentation Methods The main objective of the image segmentation is to partition an image into mutually exclusive and exhausted regions such that each region of interest is spatially continuous and the pixels within the region are homogeneous with respect to some predefined criterion. Widely used homogeneity criteria include values of intensity, color, range, texture, surface normal and surface curvatures. In medical image processing variability of data is quite high especially for analyzing anatomical structure and tissue types; hence segmentation techniques that provide accuracy, flexibility and convenient automation are of paramount importance.

1.Threshold Based Segmentation: Thresholding is a simple and effective method of segmentation for images with different intensities. These threshold techniques are

very useful for image binarization which is very essential for any type of segmentation [13]. This method assumes that images are composed of regions with different gray level ranges. A thresholding procedure determines an intensity value, called the threshold, which separates the desired classes.[8][9]

II. LITERATURE SURVEY

The important process in the automated system is brain image classification. The main objective of this step is to differentiate the different abnormal brain images based on the optimal feature set. Several conventional classifiers are available for 14 categorization but most of the earlier works depend on Artificial Intelligence (AI) techniques which yield highly accurate results than the conventional classifiers. Ronald et al (2000) have clearly illustrated usage of Artificial Neural Networks (ANN) to improve the accuracy of the classifiers.

This report was based on head and neck carcinoma detection and a comparative analysis was performed with the Linear Discriminant Classifier to show the superior nature of neural networks. Michael et al (2001) have proposed an interactive tool to classify the healthy and the tumorous MR brain images. But the accuracy proposed in this system is very low compared to the AI techniques. Though this approach claimed a faster convergence rate, it may not be much useful because of its low accuracy. This report mainly concentrated on improving the convergence rate only.

Laxmi Narayana Pondhu et.al (2018) We have various machine algorithms for gender classification but choosing best one is important task. For selecting best algorithm we conducted experimental study on machine learning algorithms for gender classification. In this experimental study of machine learning algorithms, we analyzed performance of various algorithms for gender classification using voice dataset. From this study we concluded that SVM and ANN are giving best results. After tuning parameters ANN outperforms SVM giving accuracy 99.87% on test data.

Halil Ibrahim Bulbul et.al (2017) The ECG uses some methods to diagnose these cardiac arrhythmias and tries to correct the diagnosis. ECG signals are characterized by a collection of waves such as P, Q, R, S, T. These five waves are preformed, wave transformed, and classified. In the current literature, the P, Q, R, S, T waves in ECG signals are classified using some machine learning techniques. In the work to be done, MLP (Multi Layer Perceptron) and SVM (Support Vector Machine) classification techniques which are not compared with each other using these signals will be compared. Is study, BP (Back Propagation) algorithm with MLP classifier and K-A (Kernel-Adatron) algorithm with SVM classifier were used. In addition, the use of these methods is new in the field of ECG classification. It will try to find a more effective method with new uses in the study and the literature will contribute to this area.

In addition, wave transformation techniques such as DWT, DCT, and CWT will be used to increase the success of the classification used in the study. This will lead to the most effective classification method in the existing data set. In the work to be done, it is aimed to bring improvements to the classification methods used in existing studies. It is aimed to develop a method to improve the calculation time and standard classification performance of MLP and SVM, and it is aimed to contribute to the informed consciousness of this work.

Mittal Bhatt et.al (2019) Lower Back Pain (LBP) is not a disease, but it is condition of spine, and now days it becomes very common irrespective of age. An Expert System (ES) is an intelligent tool used in medical field for various roles like prediction, diagnosing, interpreting. LBP can be caused by so many reasons and its identification in early stage will make the management of it very effective and also prevent it to become chronic. In this research, an Advanced Kernel is designed in Support Vector Machine (SVM)-Supervised Learning, gives more accurate results. After that the efficiency is compared with effectiveness of the different attributes from the dataset.

Ma. Madecheen S. Pangaliman et.al (2018) The trend of technology nowadays requires massive machine-to-machine communications and this can be done only through the application of artificial intelligence, deep learning, and machine learning to different devices through wireless sensor networks. One of the applications is through the development of acoustic disdrometer. Acoustic disdrometer is a tool that measures the amount of rainfall through the sound produced as the raindrops hit the piezoelectric sensors. With this, the main purpose of this study is to develop predictive models through the application of machine learning algorithms that can be used to categorize the intensity of the amount of rainfall from ambient noise. In the study, there were three machine learning algorithms that were used, namely: support vector machine (SVM), k-nearest neighbors and Naïve-Bayes classifier. All models obtain confusion matrix (CM) accuracies of 99.14%, 99.14% and 89.27%, respectively. These predictive models were successfully implemented and validated through cross validation (CV) and out-of-sample accuracies.

Sachin Shetty et .al (2016) Parkinson's Disease (PD) is a neuro-degenerative disease which affects a persons mobility. Tremors, rigidity of the muscles and imprecise gait movements are characteristics of this disease. Past attempts have been made to classify Parkinsons disease from healthy subjects but in this work, effort was made to focus on the specific gait characteristics which would help

differentiate Parkinsons Disease from other neurological diseases (Amyotrophic lateral sclerosis (ALS) and Huntingtons Disease) as well as healthy controls. A range of statistical feature vector considered here from the Time-series gait data which are then reduced using correlation matrix. These feature vectors are then individually analysed to extract the best 7 feature vectors which are then classified using a Gaussian radial basis function kernel based Support vector machine (SVM) classifier. Results show that the 7 features selected for SVM achieves good overall accuracy of 83.33%, good detection rate for Parkinsons disease of 75% and low false positive results of 16.67%.

III. PROPOSED APPROACH

The proposed work will also take input from the output of this application and integrate them with the concept of ontology. Fig 1 . shows a steps for the proposed flow Following are the steps of Tumor Detection Segmentation partitions the image into set of semantically meaningful, homogenous, and non -overlapping regions of similar attributes such as intensity, depth, colour or texture.

Image segmentation is performed to locate the tumor region of the MRI image. Segmentation partitions the image into set of semantically meaningful, homogenous, and non -overlapping regions of similar attributes such as intensity, depth, colour or texture [1]. The ROI part is extracted from the brain MRI image using a threshold based segmentation procedure. Image thresholding is one of the simplest and effective, segmentation procedures. It separates the image into desired classes based on an intensity value called as threshold.

Image Acquisition: Images are obtained using MRI scan and these scanned images are displayed in a two dimensional matrices having pixels as its elements. These matrices are dependent on matrix size and its field of view. Images are stored in Image File and displayed as a gray scale image. The entries of a gray scale image are ranging from 0 to 255, where 0 shows total black color and 255 pure white colors. Entries between these ranges vary in intensity from black to white.

Image To Gray Scale:- An MRI image is chosen from the file to be processed. This image is converted to gray scale image. These images have shades of gray between 0 to 255, where 0 corresponds to black and 255 to white for instance.

Noise Removal: Many filters are used to remove the noise from the images. Linear filters can also serve the purpose like Gaussian, averaging filters. For example average filters are used to remove salt and pepper noise from the image. Because in this filter pixel's value is replaced with its neighborhood values .

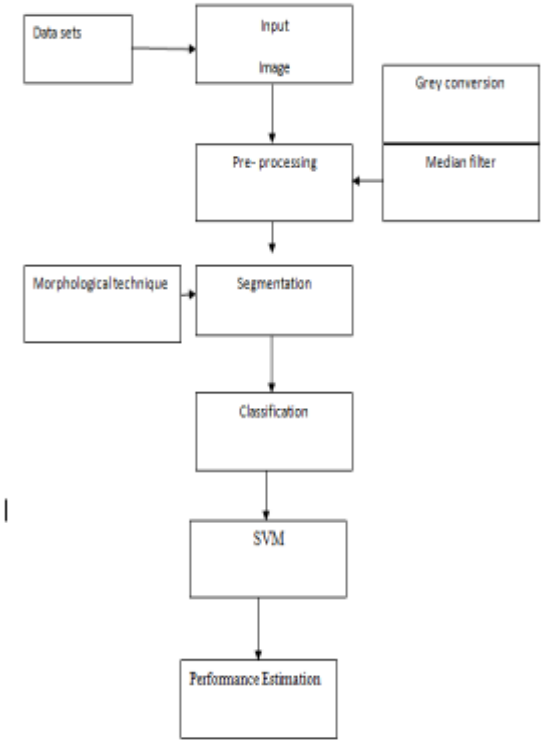

Fig.2.proposed flow chart.

Median filter is also used to remove the noise like salt and pepper and weighted average filter is the variation of this filter and can be implemented easily and give good results. In the median filter value of pixel is determined by the median of the neighboring pixels. This filter is less sensitive than the outliers.

Image Sharpening: Sharpening of the image can be achieved by using different high pass filters. As now noise is been removed by using different low pass filters, we need to sharpens the image as we need the sharp edges because this will help us to detect the boundary of the tumor. Gaussian high pass filter is used to enhance the boundaries of the objects in the image. Gaussian filter gives very high rated results and used very widely to enhance the finer details of the object.

Watershed Segmentation: It is one of the best methods to group pixels of an image on the basis of their intensities. Pixels falling under similar intensities are grouped together. It is a good segmentation technique for dividing an image to separate a tumor from the image. Watershed is a mathematical morphological operating tool. Watershed is normally used for checking output rather than using as an input segmentation technique because it usually suffers from over segmentation and under segmentation.[14] The resultant image from thresholding segmentation is applied to watershed segmentation to segment it. The classical paradigm of watershed segmentation consists determining markers for each region of interest. The major idea of watershed

segmentation is based on the concept of topographic representation of image intensity. So, controller watershed segmentation is used here for segment an MRI . The result of the image segmentation is a set of segment that collectively covers the entire image. Each of the pixels in a region is similar with respect to some characteristic such as intensity, colour or texture.

Morphological Operators: After converting the image in the binary format, some morphological operations are applied on the converted binary image. The purpose of the morphological operators is to separate the tumor part of the image. Now only the tumor portion of the image is visible, shown as white color. This portion has the highest intensity than other regions of the image. Morphological operators are applied after the watershed segmentation. Some of the commands used in morphing ow, we are going to talk about all steps for the proposed system for Preprocessing Most of the real life data is noisy, inconsistent and incomplete and therefore pre-processing becomes necessary. Image preprocessing is one of the preliminary steps that are highly required to ensure the high accuracy of the subsequent steps. The raw MR images usually consist of many artifacts such as patient motions duration imaging times, intensity in homogeneities, cranial tissues, thermal noise and existence of any metal things in imaging environment and film artifacts or label on the MRI such as patient name, age and marks etc. which reduces the overall accuracy.

Linear filters reduce noise by updating the pixel values by the weighted average of neighborhood pixels but it degrades the image quality substantially. On the other hand, non linear filters preserve edges but degrade the fine structures. Several preprocessing techniques have been analyzed and surveyed in this section. Images Enhancement and Filtering: Image enhancement is the improvement of digital image quality without any knowledge about the original source image degradation. The enhancement methods mainly divide into two methods, direct and indirect methods. In direct method is to show the contrast of the image and then enhance the contract but in the indirect method contrast of the image is not essential.

Under-enhanced when some regions of the image may be over-enhanced are the great disadvantage of the contrast enhancement methods. Mainly image enhancements are the intensity and contrast manipulation, noise reduction, undesirable background removal, edges Sharpening, filtering etc. Image enhancement methods improve the visual appearance of images from MRI and the contrast enhancing brain volumes were linearly associated. The enhancement activities are removal of film artefacts and labels, filtering the images. Median Filter, Low pass Filter, Gradient Based Method, Prewitt edge-finding filter, Nonlinear Filter, V-filter, and other filter with contrast Enhanced filter are shortly describe below. There are several filtering technology's which can improve the MRI image quality but there are several advantage and disadvantage which describe very shortly individually.

Median Filter: It can remove the high frequency noise components from MRI images without disturbing the edges and is used to reduce salt and pepper noise [5]. It considers each pixel in the image in turn and looks at its nearby pixel neighbors to decide whether or not it is a representative of its surroundings. Filter replaces each pixel value with the median of neighboring pixel values. Its advantage over mean filter is that median is a more robust average than the mean and so the median value will not be affected signicantly by a single very unrepresentative pixel in the neighborhood

IV. PERFORMANCE ANALYSIS

In this section the works of three classification techniques The factors involved in performance comparison were listed below;

- Accuracy
- Sensitivity
- Error rate
- Specificity

Accuracy: Accuracy is calculating the ratio of number of correct assessment to the total number of assessments. In the entire dataset initially the number of relevant images were extracted and compared to entire dataset by applying the below mentioned formula in which data quality and errors were the important factors which are measure in terms of percentages (%).

$$Accuracy=TN+TP/TN+TP+FN+FP$$

Sensitivity Initially total number of true positive and false negative assessments is extracted from that ratio of the number of true positive assessments to the total number is calculated to get the sensitivity result. The correctly identified data's declare the degree of positive values. The calculation part of sensitivity is done by applying the below formula and it's measured in terms of percentage (%).

$$Sensitivity= TP/TP+FN$$

Specificity: The specificity helps in predicting the impact of changes in the output because of its changes in input dataset. The correctly identified negative values give the Specificity which is also measured in terms of percentage (%). The representation of thespecificity formula is the ratio of the number of true negative assessments to the total number of true negative and false positive assessments.

$$Specificity= TN/TN+FP$$

V. CONCLUSION

The proposed classification system with the efficient segmentation technique classifies the normal and

abnormal MRI brain tumor . It is implemented will be in MATLAB. The performance of the classifier system in terms of statistical measures such as sensitivity, specificity and classification accuracy will be analyzed.

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