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Brain Tumor Detection Using Various Classification Techniques

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ABSTRACT
Brain tumor detection is one of the most challenging tasks. Using MRI image it is possible to detect brain tumor. The detection can be done by using various image techniques such as water segment, edge detection, region growing and thresholding. The segmentation of brain tumors in magnetic resonance images (MRI) is a challenging and difficult task because of the variety of shapes, locations and image intensities. The quantitative analysis of brain tumor allows obtaining useful key indicators of disease progression. The proposed method can be used successfully and applied to detect the contour of the tumor and its geometrical dimensions. This paper presents an approach in computer-aided diagnosis for early prediction of brain tumor using texture features and neural network classification. It describes the proposed strategy for detection; extraction and classification of brain tumor from MRI images of brain. This incorporates segmentation and morphological functions; which are the basic functions of image processing. This process includes tumor segmentation, tumor detection and severity analysis. Severity of the tumor is analyzed using artificial neural network by classifying them into various classes of brain tumor.
Keywords: MRI image, Brain Tumor, Texture Features, Artificial Neural Network, Severity Analysis.

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I. INTRODUCTION

The brain is the center of the nervous system, and it is the most complex organ in the human body. It is a non- replaceable and soft and spongy mass of tissue. Therefore, any damage or harm in the brain will cause problems for personal health including mobility or cognition. The brain tumor is a group of abnormal cells that grows inside the brain or around the brain. A brain tumor does not only impact the immediate cells in its location but it also can cause damage to surrounding cells by causing inflammation [1].

1.1 Structure of brain cell

The brain is a multilayered web of cells: nerve cells (neurons) and vastly more numerous Glial cells that stabilize the chemical environment and regulate and protect neurons.

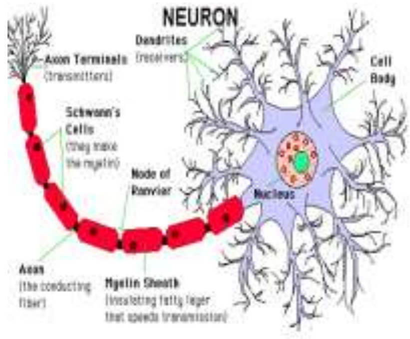


Fig 1. Structure of brain cell

The outmost layer, the cerebral cortex, is a fraction of an inch thick but contains 70 percent of all neurons. This most evolved part of the brain is divided into lobes specialized to regulate sensory experience, language and memory, and our sense of space. The frontal lobe is the most distinctively human region, responsible for judgment, planning and decision making. Beneath the cortex are areas such as the basal ganglia, which control movement; the limbic system, central to emotion; and the hippocampus, a keystone of memory. The primitive brainstem regulates balance, coordination and life-sustaining processes such as breathing and heartbeat. Throughout the brain, neurons communicate with one another through interlocking circuits. When a neuron is stimulated, it generates a tiny electrical current, which passes down a fiber, or axon. The end of the axon releases neurotransmitters chemicals that cross a microscopic gap, or synapse to stimulate other neurons nearby. The process may be repeated thousands of times to create a circuit of electrical signals that produces movement, emotion, a sensory experience or thought. Actually, a neuron typically communicates with many others simultaneously, and will or won't fire depending on the sum of signals it receives. Neuron-to-neuron activity extends widely, linking lobes and levels of the brain. Bundles of axons, "white matter," efficiently carry signals from region to region, like long-distance cables [2].

II. BRAIN TUMOR AND TYPES

Tumor

Tumor is a mass of cell that is formed by accumulation of abnormal cells. The complex brain tumors can be categorized on the basis of their origin, growth pattern and malignancy. It can be detected as benign the non-cancerous or malignant the cancerous [25].

Brain Tumor

A brain tumor is a mass of cells that have grown and multiplied uncontrollably i.e. a brain tumor is an uncontrolled growth of solid mass formed by undesired cells either normally found in the different parts of the brain such as Glial cells, neurons, lymphatic tissue, blood vessels, pituitary and pineal gland, skull, or spread cancers mainly located in other organs. Brain tumors are classified based on the type of tissue involved in the brain, the positioning of the tumor in the brain, whether it is benign tumor or malignant tumor and other different considerations. Brain tumors are the solid portion that permeate the surrounding tissues or distort the surrounding structures. Treatment techniques for the brain tumor are as follows:

- Surgery
- Radio therapy
- Chemotherapy

2.1 Structure of Brain

Generally, human brain includes three major parts controls different activity.

i) **Cerebrum**-The cerebrum controls learning, thinking, emotions, speech, problem solving, reading and writing. It is divided into right and left cerebral hemispheres. Muscles of left side of the body are controlled by right cerebral hemispheres and muscles of right side of the body are controlled by left cerebral hemispheres.

ii) **Cerebellum**-The cerebellum controls movement, standing, balance and complex actions.

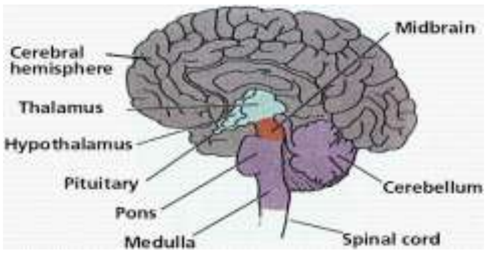


Fig 2.Structure of brain

iii) **Brain stem**-Brain stem joints the brain with spinal cord. Brain stem controls blood pressure, body temperature and breathing and controls some basic functions [3].

Based on the property tumor are six types.

- Gliomas
- Medulloblastoma
- Lymphoma,
- Meningioma
- Craniopharyngioma
- Pituitary adenoma.

Gliomas represent the major type of primary brain tumors and are often associated with fatal outcome because of their highly invasive growth pattern and their frequent resistance to therapies. A growing number of researches have been focused on exploring the molecular modulatory network involved in the development of glioma as well as investigating the effective therapeutic targets [4].

Medulloblastoma (MB) is the most common primary brain tumor in children. It is generally believed that the overwhelming majority of cases reported with extra neural metastasis occur in patients who underwent a craniotomy. At present, typical treatments for high-risk childhood MB include maximal surgery, craniospinal radiation therapy and adjuvant chemotherapy [9].

Lymphoma is also known as brain lymphoma or central nervous system lymphoma. Primary cerebral nervous system lymphoma (PCNSL) is a rare type of non-Hodgkin lymphoma (NHL) which is confined to the CNS and the eyes. PCNSL should be distinguished from secondary CNS involvement from a systemic NHL [22].

Meningiomas are the second most common primary central nervous system tumors, secondly only to Glial tumors. They comprise approximately 25% of all spinal tumors and 15% of all intracranial tumors. Meningiomas only rarely extend or metastasize extra cranially, with extra cranial presentation comprising only 2% of cases. Intracranial meningiomas are more common in women, whereas extra cranial meningiomas are more common in men [21].

Craniopharyngioma an among primary brain tumors, craniopharyngiomas and germ cell tumors (GCTs) are common in the Japanese population. The epidemiology, markers, and locations of the tumors are useful for diagnosing both Craniopharyngioma and GCTs.

Pituitary adenomas are the most common lesion found in the seller space, and ectopic pituitary adenomas (EPAs) are extremely rare. Their origin is identical to the adenohypophysis but they grow completely outside of the sellaturcica, without any continuity with the interstellar normal pituitary gland [19]. The pituitary gland is an important endocrine organ that controls basic physiological processes, such as growth, fertility, metabolism, and stress response [20].

2.2 Types of Brain Tumors

There are two basic kinds of brain tumors.

- primary brain tumors(benign tumor)
- secondary brain tumor(malignant tumor)

Primary brain tumor

Primary brain tumors are rare, accounting of all cancers by incidence, but have high rates of morbidity and mortality. People diagnosed with primary brain tumors experience high levels of physical, neurological, cognitive and psychological morbidity, and subsequent changes in family, occupational and social roles. A number of studies have documented impairments to patients' functional outcomes and high rates of unmet supportive care needs. Treatment guidelines for adults diagnosed with glioma (the most common primary brain tumors) recommend that patients be offered multidisciplinary rehabilitation to address residual deficits during and following treatment. Referral to information, support and counseling services, and sources of practical assistance, are also recommended to address patients' concerns and needs. Despite these recommendations, the extent to which adults diagnosed with primary brain tumors utilize resources or services to address their psychosocial, informational, or practical needs is uncertain [5].

Secondary brain tumor (Malignant brain Tumor)

Malignancy is the type of tumor that grows worse with the passage of time and ultimately results in the death of a person. Malignant is basically a medical term that describes a severe progressing disease. Malignant tumor is a term which is typically used for the description of cancer [3]. The malignant brain tumors in adults are of neuroepithelial origin and belong to the group of glioma, based on their resemblance to Glial support cells of the brain, atrocities and oligodendrocytes. Glial tumors are further classified in grades according to their clinical manifestation and malignancy [10].

III. SYMPTOMS OF BRAIN TUMOR

Nowadays, the occurrence of brain tumors has been on the rise. Unfortunately, many of these tumors will be detected too late, after symptoms appear. It is much easier and safer to remove small tumors than a large one. About 60 percent of glioblastomas start out as a lower-grade tumor. But small tumors become big tumors. Low-grade gliomas become high-grade gliomas. Once symptoms appear, it is generally too late to treat the tumor, so there is need of an automated tumor detection system which will help in treatment of tumor. Computer-assisted surgical planning and advanced image guided technology have become increasingly used in Neuro surgery.

Brain tumors may have different types of symptoms ranging from headache to stroke, so symptoms will vary depending on tumor location. Different location of tumor causes different functioning disorder.

The general symptoms of brain tumor are:

- Persistent headache
- Seizures
- Nausea and vomiting
- Eyesight, hearing and/or speech problems
- Loss of sensation in arm.
- Walking and/or balance difficulties.
- Problems with cognition and
- Concentration [16].

IV. DIAGNOSIS OF BRAIN TUMOR

4.1 Computed Tomography (CT) scans

CT scanning is the imaging modality of choice for the initial assessment of TBI due to its rapid acquisition and high sensitivity for detection of various deleterious secondary insults. Similarly, for evaluation of facial fractures, multi detector CT (MDCT) of the face has become the principle diagnostic modality because of the ease of patient positioning, minimal dependence on patient cooperation, and its major advantage of creating multi planar reformatted image. Regarding the application of facial CT to TBI patients requiring head CT as an aid for diagnosing concomitant facial fractures in the emergency department (ED), only one study conducted by Holmgren et al. using axial CT scanning has been reported. However, to the best of our knowledge, in the era of advanced helical MDCT, no studies have investigated the value of adding multi planar reformatted facial CT images to routine head CT [6].

4.2 Magnetic Resonance Imaging (MRI) scans

Magnetic resonance imaging (MRI) provides detailed information about brain tumor anatomy, cellular structure and vascular supply, making it an important tool for the effective diagnosis, treatment and monitoring of the disease. Magnetic resonance imaging (MRI) is a noninvasive medical test that helps physicians diagnose and treat medical conditions. MRI uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures. The images can then be examined on a computer monitor, transmitted electronically, printed or copied to a CD. MRI does not use ionizing radiation (x-rays). Detailed MR images allow physicians to evaluate various parts of the body and determine the presence of certain diseases [13]. MRI is commonly used in the medical field for detection and visualization of details in the internal structure of the body. It is used to detect the differences in the body tissues which is considerably better technique as compared to computed tomography(CT).

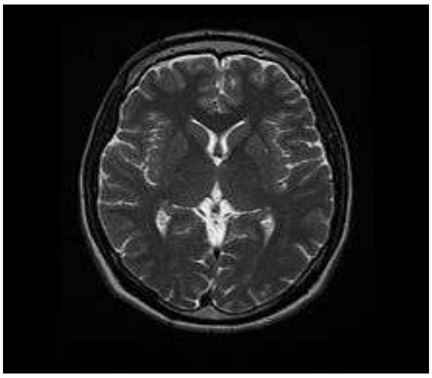


Fig 3. MRI images of brain

Thus this technique become a special technique especially for the brain tumor detection and cancer imaging. Protons and neutrons of an atom have an angular momentum which is known as a spin. These spins will cancel when the number of subatomic particles in a nucleus is even. Nuclei with odd number will have a resultant spin. This forms the basis of magnetic resonance imaging. A magnetic resonance imaging (MRI) scanner uses powerful magnets to polarize and excite hydrogen nuclei (single proton) in human tissue, which produces a signal that can be detected [8]. The quality of image is main important in brain tumor. MRI provides an unparallel view inside the human body. In MRI scans will show the detailed information extra ordinary compared to any other scanning like X-ray, CT scans. The contrast of tumor cell is high compared to normal brain cell [7].

Contrast in MRI

These different MRI modalities produce different types of tissue contrast images, thus providing valuable structural information and enabling diagnosis and segmentation of tumors along with their sub regions. Four standard MRI modalities used for glioma diagnosis include T1-weighted MRI (T1), T2-weighted MRI (T2), T1-weighted MRI with gadolinium contrast enhancement (T1-Gd) and Fluid Attenuated Inversion Recovery (FLAIR) (see Fig. 4). During MRI acquisition, although can vary from device to device, around one hundred and fifty slices of 2D images are produced to represent the 3D brain volume. Furthermore, when the slices from the required standard modalities are combined for diagnosis the data becomes very populated and complicated.

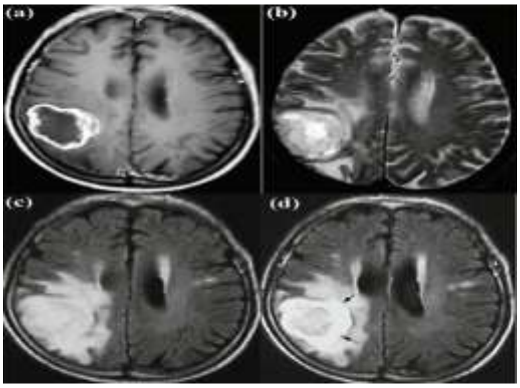


Fig. 4. Four different MRI modalities showing high grade gliomas, each enhancing different sub regions of the tumor.

Generally, T1 images are used for distinguishing healthy tissues, whereas T2 images are used to delineate the edema region which produces bright signal on the image. In T1-Gd images, the tumor border can easily be distinguished by the bright signal of the accumulated contrast agent (gadolinium ions) in the active cell region of the tumor tissue. Since necrotic cells do not interact with the contrast agent, they can be observed by hypo intense part of the tumor core making it possible to easily segment them from the active cell region on the same sequence. In FLAIR images, signal of water molecules are suppressed which helps in distinguishing edema region from the Cerebrospinal Fluid (CSF) [17].

4.3 MRI De-noising and Enhancement

MRI De-noising algorithms are to perform noise reduction, or de-noising, based on morphology operation techniques. The MRI Brain image first loaded from the database, then the noise is removed from the MRI image with preserved the edge details and produce the image with good enhancement. The algorithm depends on implementing of mathematical morphology operations eroding and dilation. These operations process the image according to shape by hit or miss transformation and depending on the selected structure of element. The algorithm processes the noises image after dividing the image into three channels (Red, Green, and Blue), and in the end concatenation these three sub images to produce a final de-noising image [24].

V. BRAIN TUMOR DETECTION

The brain tumor detection is an important application in medical field. Because it provides anatomical information of abnormal tissues in brain which helps the doctors in planning the treatment. For brain tumor detection MRI and CT scans are used [27]. The medical problems are severe if tumor is identified at the later stage. Hence diagnosis is necessary at the earliest. MRI is the current technology which enables the detection, diagnosis and evaluation [28].

Pathological brain detection system (PBDS) can help physicians interpret medical brain images accurately. In hospitals, the picture archiving and communication system (PACS) can provide either 3D brain or only a single slice that is associated to the foci within the brain. Nevertheless, scanning the whole 3D brain is expensive and time consuming, hence, a PBDS for single slice brain images. Neuroradiologists used many neuro imaging methods to detect the brains by two ways: structural and functional. The structural imaging measures the inner of the brain structure, while the functional imaging measures its functions. In hospitals, structural imaging is commonly used by magnetic resonance imaging (MRI), since it displays better resolution for brain soft tissues and it does not relate to any radiations, compared to traditional X-ray and computed tomography (CT) [12].

Pathological brain detection (PBD) was of essential importance. It can help physicians make decisions, and to avoid wrong judgments on subjects. Magnetic resonance imaging (MRI) features in high-resolution on soft tissues in the subjects' brains, generating a mass dataset. There are numerous works on using brain MR images for solving PBD problems. Recent computer-aided diagnosis (CAD) systems of PBD consisted of two types: to detect pathological from healthy brains, and to differentiate severity degrees [12].

5.1 Automatic Detection of brain tumor

The Automatic detection of tumor in Brain MR Image is challenging due to various limitations such as acquired MR image complexity and properties, pathology, extraction of brain image and tumor boundaries from its background image and MR image analysis based on intensity. Automatic segmentation and detection of brain tumor is a notoriously complicated issue in Magnetic Resonance Image. The similar state-of-art segmentation methods and techniques are limited for the detection of tumor in multimodal brain MRI [29].

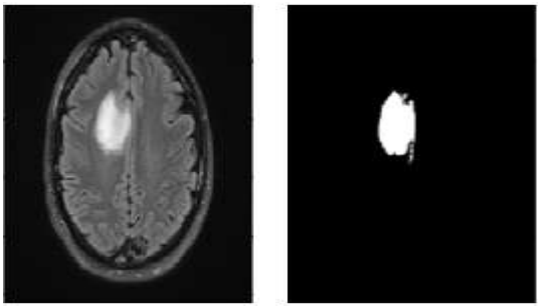
Automated Brain Tumor Detection of MRI images

Automated brain tumor detection from MRI images is one of the most challenging tasks in today's modern Medical imaging research. Automatic detection requires brain image segmentation, which is the process of partitioning the image into distinct regions, is one of the most important and challenging aspect of computer aided clinical diagnostic tools. Noises present in the Brain MRI images are multiplicative noises and reductions of these noises are difficult task. The minute anatomical details should not be destroyed by the process of noise removal from clinical point of view. These makes accurate segmentation of brain images a challenge. However, accurate segmentation of the MRI images is very important and crucial for the exact diagnosis by computer aided clinical tools.

A large variety of algorithms for segmentation of MRI images had been developed. Surgical planning, postsurgical assessment, abnormality detection, and many other medical applications require medical image segmentation. In spite of wide number of automatic and semi automatic image segmentation techniques, they fail in most cases largely because of unknown and irregular noise, in-homogeneity, poor contrast and weak boundaries which are inherent to medical images [13].

5.2 Image Segmentation of Brain Tumor

Image segmentation is the procedure of partitioning a digital image into multiple segments (sets of pixels, also referred to as super-pixels). The target of segmentation would be to change or simplify the representation of a graphic into something that's more meaningful and better to analyze. Image segmentation is usually used to locate objects and boundaries in images. Precisely, the segmentation of image is the procedure of assigning a name to every pixel in a graphic in ways that pixels with the exact same label share certain visual characteristics. MRI Images of brain tumor cannot exactly denote the position of brain tumor, so to acquire the precise position of tumor in the MRI image pre-processing, segmentation; morphological operation and subtraction are used. This provides the precise shape of the tumor for the reason that MRI image and finally detection of brain tumor in MRI images is achieved. The consequence of image segmentation is an accumulation of segments that collectively cover entire image, or perhaps a set of contours extracted from the graphic.



Original image segmented image

Fig 5. Brain Tumor Segmentation

Most of the pixels in an area resemble for much characteristic or computed property, including color, intensity, or texture. Adjacent regions are significantly different dependent upon exactly the same characteristic(s). When placed on stack bits of images, typical in medical imaging, the resulting contours after image segmentation enables to create 3D reconstructions with assistance from interpolation algorithms like matching cubes [14].

5.3 Image segmentation Techniques

Image segmentation is also used to differentiate different objects in the image, since our image is divided into foreground and background, whereas foreground of image is related to the area of interest, and background is the rest of the image. Hence, image segmentation will separate these two parts from one another. The segmentation like technique are explained following like,

Region based segmentation

Region based segmentation is used the threshold in order to separate the background from an image, whereas neural network based techniques used the learning algorithm to train the image segmentation process. The technique pixels that are related to an object are grouped for segmentation. The thresholding technique is bound with region based segmentation. The thresholding technique is bound with region based segmentation. The area that is detected for segmentation should be closed. Region based segmentation is also termed as "Similarity Based Segmentation". There won't be any gap due to missing edge pixels in this region based segmentation. Region based segmentation methods are categorized into three main categories, i.e., region growing, region splitting, and region merging.

Edge based segmentation

Edge based segmentation is used the most common method of detecting boundaries and discontinuities in an image. An edge is a set of connected pixels, i.e., same intensity level, between two adjacent pixels and can be distinguished by estimating the intensity gradient. Edge detection is a basic step for image segmentation process. It divides an image into object and its background. Edge detection divides the image by observing the change in intensity or pixels of an image. Gray histogram and Gradient are two main methods for edge detection for image segmentation.

Fuzzy based segmentation

Fuzzy based segmentation is used in order to analyze images, and provide accurate information from any image. Fuzzification function can be used to remove noise from image as well. A gray-scale image can be easily transformed into a fuzzy image by using a fuzzification function.

Threshold based segmentation

Threshold based segmentation is based on local pixel intensity levels. The current image is compared to the background image and a threshold value decides if the pixel differs enough to belong to the foreground. Threshold based segmentation is an old, simple and popular technique for image segmentation. Image segmentation by thresholding is a simple but powerful approach for segmenting images having light objects on dark background. Thresholding operation converts a multilevel image into a binary image.

ANN (Artificial Neural Network) segmentation

ANN segmentation is neural net is an artificial representation of human brain that tries to simulate its learning strategies and can be used for decision making process. An artificial neural network is often called a neural network or simply neural net. In recent years, artificial neural networks have been widely used to solve the problem of medical image segmentation. Neural network that simulate life, especially the human brain's learning procedures, constitutes a large number of parallel nodes. Each node can perform some basic computing. The learning process can be achieved through the transferring the connections among nodes and connection weights. Its main advantage is not dependent on the probability density distribution function. It can also prove the segmentation results when the data deviation from the normal situation. Neural network can also reduce the requirements of expert intervention during the images segmentation process [15].

VI. IMAGE CLASSIFICATION

First the images are normalized and realigned as per the first image of the sequence. This is done to ensure that when placed on a quadrant each image has the same point on the brain scan as the origin. Since the image size, varies depending on sequence, all images are re-sized. Once the images are realigned and re-sized, feature extraction and classification follow. For feature extraction the image was divided into square grids of pixels size [30].

In order to classify the input image as,

- Supervised
- Unsupervised

Supervised classification

Supervised classification is a machine learning approach in which training data are used to construct the model and test data are used to evaluate the constructed model on unseen data to measure the performance of algorithm. There are a number of classifiers that exist to classify data [31].

Unsupervised classification

Unsupervised representation learning is a fairly well studied problem in general computer vision research, as well as in the context of images. A classic approach to unsupervised representation learning is to do clustering on the data (for example using K-means), and leverage the clusters for improved classification scores. In the context of images, one can do hierarchical clustering of image patches to learn powerful image representations [37].

VII. CLASSIFICATION TECHNIQUES

7.1 Support Vector Machine

SVM is a systematic technique for two class problems. The SVM classifier is used in many research areas because it gives high performance in pattern recognition and image processing tasks. SVM is most likely used in problems with small training dataset and high dimensional feature space. Like neural networks, SVM needs two stages; training and testing. The SVM can be trained by features given as an input to its learning algorithm. During training, the SVM finds the suitable margins between two classes. Features are named according to class associative with specific class. SVM occupies no local minima and by initiating the idea of hyper planes, it overcomes the problem of neurons selection [36].

7.2 Probabilistic Neural Networks

Probabilistic (PNN) and General Regression Neural Networks (GRNN) have similar architectures, but there is a fundamental difference: Probabilistic networks perform classification where the target variable is categorical, whereas general regression neural networks perform regression where the target variable is continuous. If you select a PNN/GRNN network, DTREG will automatically select the correct type of network based on the type of target variable.

All PNN networks have four layers:

Input layer -There is one neuron in the input layer for each predictor variable. In the case of categorical variables, N-1 neurons are used where N is the number of categories. The input neurons (or processing before the input layer) standardize the range of the values by subtracting the median and dividing by the interquartile range. The input neurons then feed the values to each of the neurons in the hidden layer.

Hidden layer -This layer has one neuron for each case in the training data set. The neuron stores the values of the predictor variables for the case along with the target value. When presented with the x vector of input values from the input layer, a hidden neuron computes the Euclidean distance of the test case from the neuron's center point and then applies the RBF kernel function using the sigma value(s). The resulting value is passed to the neurons in the pattern layer.

Pattern layer / Summation layer -The next layer in the network is different for PNN networks and for GRNN networks. For PNN networks there is one pattern neuron for each category of the target variable. The actual target category of each training case is stored with each hidden neuron; the weighted value coming out of a hidden neuron is fed only to the pattern neuron that corresponds to the hidden neuron's category.

Decision layer -The decision layer is different for PNN and GRNN networks. For PNN networks, the decision layer compares the weighted votes for each target category accumulated in the pattern layer and uses the largest vote to predict the target category [32].

7.3 Convolution Neural Network (CNN)

Convolution Neural Network (CNN) is a form of deep learning where the structure is made up of many hidden layers and parameters. Further, the CNN can self-learn and self-organize which does not require supervision. CNN has been applied in diverse applications such as object recognition, image classification, and handwriting classification. It is also employed in the medical field as an automated diagnostic tool to aid clinicians. It is noted that CNN eliminates the need for pre-processing and separate feature extraction technique. Therefore, it can help to reduce the burden during training and selecting the best feature extraction technique for the automated detection of arrhythmias. Also, there is a possibility of attaining better performance if we can achieve a fitting learning based on the trained hidden layers by learning the structure of the data [40].

7.4 K- Nearest Neighbor

In k-NN, the observation having the shortest distance has the chance to belong the same class. The probability of a point 'x' belongs to a class can be estimated by the proportion of training points in a specified neighborhood of 'x' that belongs to that class. The points can be classified by majority vote and similarity degree sum method. In the majority, voting method, those points which belong to each class in the neighborhood are counted and the class to which the highest proportion of points belongs is the likely classification of 'x'. In similarity degree, sum method, similarity scores are calculated for each class, based on the k-Nearest Neighbors and classification of 'x' is decided on the basis of class which has the highest similarity score. The majority voting method is frequently used as compared to the similarity degree sum method due to its lower sensitivity to outliers. In k-NN we have used Euclidean Distance. The Euclidean distance between each test point ft and training set points, each with n attributes, is calculated.

The steps of k-NN are summarized as:

- The selection of 'k'.
- Calculation of distance.
- Sorting of distance in ascending order.
- Finding 'k' class value.
- Finding the dominant class.

The selection of optimal 'k' value is a challenging task, the small value of 'k' will not be appropriate to estimate the population proportions accurately around the test point. The selection of larger value of 'k' creates more biased and less variance in probability estimates in the result. Therefore 'k' should be selected as larger to minimize the probability of a non-biased decision, and should be as small so that included points can give accurate estimate of class [39].

7.5 K-means clustering

K-Means is the one of the unsupervised learning algorithm for clusters. Clustering the image is grouping the pixels according to the some characteristics. In the k-means algorithm initially we have to define the number of clusters k. Then k-cluster center are chosen randomly. The distance between the each pixel to each cluster centers are calculated. The distance may be of simple Euclidean function. Single pixel is compared to all cluster centers using the distance formula. The pixel is moved to particular cluster which has shortest distance among all. Then the centroid is re-estimated. Again each pixel is compared to all centroids. The process continuous until the center converges.

The steps involved in this algorithm are:

- Give the no of cluster value as k.
- Randomly choose the k cluster centers
- Calculate mean or center of the cluster
- Calculate the distance b/w each pixel to each cluster center
- If the distance is near to the center then move to that cluster.
- Otherwise move to next cluster.
- Re-estimate the center.
- Repeat the process until the center doesn't move [33].

The main advantages of this algorithm are its simplicity and low computational cost, which allow it to run efficiently on large data sets. The main drawback is that: K the number of clusters must be determined, it does not yield the same result each time the algorithm is executed and the resulting clusters depend on the initial assignments of centroids [34].

7.6 Watershed segmentation

Watershed segmentation is a gradient based segmentation, which considers the gradient map of the image. The main result we get from the watershed segmentation is the catchment basins and ridges which give a required result.

The steps involved in this algorithm are:

- Read the input image.
- Convert input image into grayscale image.
- Compute foreground markers (connected blobs and pixels).
- Compute background markers.
- Compute the Watershed transform of the segmentation function.
- Output image.

The advantage of this algorithm is that it is easy to use; the results obtained are efficient and accurate. The disadvantage of this algorithm is that it gives over segmentation.

7.7 Fuzzy C-Means

Fuzzy clustering method is basically used for pattern recognition, classification and image segmentation. In the fuzzy algorithm the fuzzy set can be a shared set which means a member from one fuzzy set can belong to another set also. Each pixel of the image is given a partial membership value.

The steps included in the algorithm are as follows:

- Select an image form the database.
- Check whether the image is in grayscale, if not convert it into grayscale.
- Covert the image into Double.
- Predefine the number of clusters and iterations.
- Convert the matrix of input image into a vector.
- Select the k-cluster centre randomly.
- Calculate the fuzzy centre
- Using the distance formula, calculate the fuzzy membership function.
- Repeat the steps 7 and 8 until a minimum value is achieved
- Stop if the condition is achieved.

The advantages of this algorithm are that it gives better results for overlapped datasets. It is better that k-means clustering. The disadvantages are that more number of iteration scan be used which will make it a longer process, it is sensitive to noise [35].

VIII. BRAIN TUMOR DETECTION TECHNIQUES

There are four main techniques for brain tumor detection as given follows:

- Tumor detection using Active Contour
- Based on Region Growing
- Brain Tumor Detection and Segmentation Using Histogram Thresholding
- Using neural network

Tumor detection using Active Contour

The way will be based on active contours evolving eventually in accordance with intrinsic geometric measures of the image. The contours which evolves will split and merge, allowing the detection of varied objects simultaneously and both interior and exterior of the boundaries. This technique is using the relation between active contours combined with computation of geodesics or minimal distance curves.

Based on Region Growing

Region growing is just a simple region-based image segmentation method. It can be classified as a pixel-based image segmentation method since it involves the decision of initial points. This process to segmentation examines neighboring pixels of initial “seed points” and determines perhaps the pixel neighbors should be incorporated with the region.

Brain Tumor Detection and Segmentation Using Histogram Thresholding

The idea is reliant mainly on three points:

- The symmetrical structure on your brain,
- Pixel intensity of image and
- Binary image conversion.

It is a well liked undeniable fact that human brain is symmetrical about its central axis and throughout this work this has been assumed that the tumor is either to the left or to even the proper side on the brain. MR image of the human brain is frequently broken into sub region in order that white matter, gray matter, blood cells and cerebrospinal fluid can simply be detected. Tumor is totally nothing nevertheless the collection of blood cells at some specific point/s. The image of a brain in MRI is represented through pixel intensity.

Using Neural Network

Artificial neural networks (ANNs) are non-linear data driven self adaptive approach rather than the traditional model based methods. They're powerful tools for modeling, particularly when the underlying data relationship is unknown. A significant feature of such networks would be the adaptive nature, where “learning by example” replaces “programming” in solving problems. This feature makes such computational models very appealing in application domains where you've got little or incomplete understanding from the problem to be solved but where training data is readily available. The symmetry, texture features, intensity and shape deformation were improved in each image. The AdaBoost classifier was utilized to find the most discriminative features to have the ability to segment the brain tumor region. Moreover, Multimodal MR Images with tumor are utilized as the floor truth for training and validation from the detection method.

The images were pre-processed as aforementioned and the four forms of features were extracted from the images to be properly used as the training data set for the classification. A leave-one-out validation was performed on the images. The workflow of this technique is shown within the next figure. Each MRI in the training set is first pre-processed to minimize the intensity bias and to remove the non-brain tissue. The pre-processing also incorporates multi-modality within-subject registration and co-registration to a typical template for cross subject comparison. Next, four kinds of features (i.e., intensity, symmetry, shape deformation, and texture features) are extracted from the pre-processed images. Feature selection and fusion are carried out using AdaBoost. For new subjects, the selected features computed in the training process will probably be extracted and tumor will probably be detected when using the trained classifier (using fig 5) [14].

Neural networks

An artificial neural network (ANN) generally called neural network (NN), is a mathematical model or computational model that is inspired by the structure and or functional aspects of biological neural networks. A neural network contains of an interconnected group of artificial neurons (processing element), working in unison to solve specific problems [23].

Artificial Neural Network

The technique, the image is mapped into a Neural Network. The neural network works in two phases- the training phase and the testing phase. Firstly the neural network was trained with training examples in the training phase. After training, the neural network is tested on the unknown instances. Neural network technique includes important step that is feature extraction. Feature extraction is very important as the features that are extracted from the input part of the neural network.

The steps included in the algorithm are as follows:

- Extract features from mammogram images.
- Create input and target for normal and abnormal class.
- The initial weights are chosen randomly.
- Calculate the predicted output [38].

Artificial Neural Network is divided into 2 categories:-

1. Feed-Forward Neural Network.
2. Recurrent Network or Feed-Backward Network.

In feed-forward neural network, the neurons are arranged in layers and they have unidirectional connections between them. They produce only one set of output values. They are called as static network because in this the output values are produced only based on current input. The output value does not depend on previous input values. They are also called as memory less network. In feedback network, the neurons have bidirectional connections between them. Feedback or Recurrent networks produce a set of values which depends on the previous input values. Feedback network is also known as dynamic network because the output values always depend on the previous input values. Back Propagation algorithm is used in feed-forward neural network.

In this network, the neurons are arranged in layers and send the output in the forward direction. The errors generated are back propagated in the backward direction to the input layer. The network receives the input by neurons in the input layer of the neural network and the output of the network is given by the neurons on an output layer of the neural network. The neural network consists of one or more intermediate hidden layers. In back propagation algorithm, the supervised learning is used. The error between the input and the computed output is calculated and back propagated. The network is trained with random weights and then later the weights are adjusted by back propagation to get the minimal error. The network is perfect if the error is minimal. In back propagation, the weights are changed each time such that the error reduces gradually. This is repeated until there is no change in the error.

Advantages of artificial neural network

- The neural networks have high parallel ability and fast computing.
- Expert intervention is reduced during the whole process.

Disadvantages of artificial neural network

- Some of the information should be known beforehand.
- They should be first trained using learning process beforehand.
- Period of training neural networks may be very long [26].

IX. PROPOSED METHODOLOGY

In this paper, Gustafson-Kessel (G-K) fuzzy clustering algorithm for brain tumour is used and MRI images are classified as normal and abnormal. G-K clustering algorithm is powerful clustering strategies which can be utilized, for example, image processing, classification and Feature extraction. Gustafson-Kessel fuzzy clustering is performed to cluster the image segments [1]. Its fundamental component is the local adaptation of the distance metric to the shape of the cluster by evaluating the cluster covariance matrix and adapting the distance-inducing matrix correspondingly. The G-K algorithm is an iterative process that keeps estimating the parameters of the clusters like the centre, matrix covariance, and the distance from the information to the centre.

The proposed G-K fuzzy method is employed to brain image classification and segmentation is done by using Histogram. The foremost objective of G-K fuzzy is to provide an excellent outcome of MRI brain cancer classification. The main feature of this method is the use of covariance matrix and distance matrix which makes it possible for clusters to have different shapes

The proposed methodology as the following steps:

- Pre-processing
- Identification and segmentation
- Feature Extraction
- Classification

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