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A Review on Brain Tumour Classification Using Support Vector Machine and Principle Component Analysis

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***Abstract* – Over the years, the enlargement in medical image processing is mounting in a marvellous manner. The rate of increasing diseases through deference to a compilation of category of cancer and other related human problems paves the way for the development in biomedical research. Consequently processing and analyzing these medical images is of high consequence for clinical diagnosis. This work focus on the stage successful classification of brain tumour images and segmentation of brain tumour data set images formulate use of the proposed hybrid logical technique the face up to and objectives on be going to of attribute extraction, image classification and segmentation for medical images will be discussed. The experimental results of proposed technique will be evaluate and validated for presentation and advantage analysis on magnetic resonance brain images, based on accuracy, sensitivity, specificity demonstrating the effectiveness of the proposed method there will be SVM , classifiers Used for identify normal and abnormal tissues from brain MR images.**

***Keywords*– SVM, Machine Learning, Brain Tumour, Segmentation,PCA**

I. INTRODUCTION

Brain tumor is the abnormal growth of a cell in the brain. All tumors are necessarily not cancerous in nature. Cancer cells are dead cells that do not enter the phase of regeneration, and they replicate very quickly affecting other healthy cells in our body which may lead to the death of a human being [1]. Brain tumor detection is a very challenging problem due to the complex structure of brain. It will segment through biopsy by the help ofa medical expert. Magnetic Resonance Imaging (MRI) andComputer Tomography (CT) are the two standard modality used for tumor detection. MRI is the most prominent one since it does not use ionizing radiation and it exhibits a greater contrast between different soft tissues of the human body. Early detection of brain tumor is one of the important factor to save the life of patients. Manual detection of brain tumor will take more time and it is expensive. The method proposed in this work will detect the brain tumour automatically from the T1-weighted MRI.

Our work focuses mainly on an accurate automatic detection of brain tumors with irregular shapes and also in images with low pixel intensity. Brain tumor is detected after applying k-means clustering method and hierarchical centroid shape descriptor [2][7]. The feature extraction and classification methods used after the tumor detection to verify the detectedtumor. Skull removal and noise removal is performed in thepre-processing step. The human brain anatomy can be classified into three groups based on its intensity. The group number increases to four if some pathological tissues like tumor appear. Gray Matter (GM), White Matter (WM), Cerebrospinal Fluid (CSF) and the tumor are the four. Hence, there will be four clusters. The remainder of this paper is structured as follows. Section 2 presents some previous works related to the automatic brain tumor detection. [10][14].

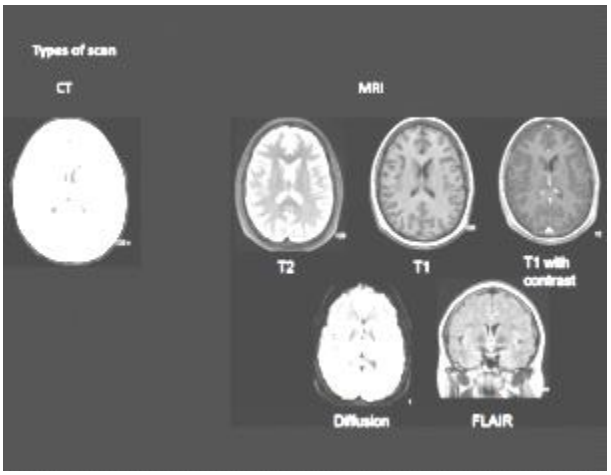

Fig. 1. Different type of MRI images.

II. RELATED WORK

Automatic brain tumor detection remains to be themost researched topic for many decades. Several works have been proposed in this area. Each of the Methods consists of advantages and disadvantages.

In [2][10] the brain tumor is segmented through two methods and it does not use any classification method. The classification methods can ensure the exact tumor area by comparing the features of MR images from the

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learning sideband testing side. The noise will occur during MRI scanning and it will lead to over segmentation in tumor detection process. Hence the noise in the image will be segmented as tumor. Automatic tumor detection in MRI [3][14] used some features like texture, shape, intensity and symmetry. This approach have limited applicability to enhance the tumor because the different types of tumors lead to an in homogeneity of their sizes,, shapes, textures, locations and intensities.

III. LITERATURE SURVEY

Annisa Wulandariet.al(2018) Brain tumor is one of disease type that attacks the brain in the form of clots. There is a way to see brain tumor in detail requires by an MRI image. There is difficulty in distinguishing brain tumor tissue from normal tissue because of the similar color. Brain tumor must be analyzed accurately. The solution for analyze brain tumor is doing segmentation. Brain tumor segmentation is done to separate brain tumor tissue from other tissues such as fat, edema, normal brain tissue and cerebrospinal fluid to overcome this difficulty, The MRI image must be maintained at the edge of the image first with the median filtering. Then the tumor segmentation process requires thresholding method which is then iterated to take the largest area. The brain segmentation is done by giving a mark on the area of the brain and areas outside the brain using watershed method then clearing skull with cropping method. In this study, 14 brain tumor MRI images are used. The segmentation results are compared brain tumors area and brain tissues area. This system obtained the calculation of tumor area has an average error of 10%.

Mircea Gurbină et.al (2019) The brain is one of the most complex organs in the human body that works with billions of cells. A cerebral tumor occurs when there is an uncontrolled division of cells that form an abnormal group of cells around or within the brain. This cell group can affect the normal functioning of brain activity and can destroy healthy cells. Brain tumors are classified as benign or low-grade (grade 1 and 2) and malignant tumors or high-grade (grade 3 and 4). The proposed methodology aims to differentiate between normal brain and tumor brain (benign or malign). The study of some types of brain tumors such as metastatic bronchogenic carcinoma tumors, glioblastoma and sarcoma are performed using brain magnetic resonance imaging (MRI). The detection and classification of MRI brain tumors are implemented using different wavelet transforms and support vector machines. Accurate and automated classification of MRI brain images is extremely important for medical analysis and interpretation.

T. A. Jemimma et.al (2018) Brain tumor detection is a tedious task in the field of medical imaging. Detection or identification of brain tumor involves segmentation of brain image, extraction of brain features and classification of abnormality in the MRI brain image. This paper proposes the state of art tumor detection techniques using the Watershed Dynamic Angle Projection - Convolution Neural Network (WDAPP-CNN). The watershed algorithm accurately segments the tumor region. The dynamic angle projection pattern extracts the textured features of the brain and the convolutional neural network classifies the tumor and non-tumor regions of the MRI brain image. The abnormality of the brain image is detected and testing is achieved through the BRATS dataset in an efficient way.

Manu Gupta et.al (2015) Brain tumor segmentation is an important procedure for early diagnosis of brain tumor and planning of its treatment. However it is still a difficult task due to variations in size, shape and location of tumor. In this paper, we propose a novel brain tumor segmentation method using T2-weighted brain MR images by integrating symmetry property of brain with region growing approach. Bilateral symmetry property of brain is used in our method to identify various regions having probability of presence of the tumor. Identification of exact tumor location and its segmentation is then performed by using region growing technique. Qualitative and quantitative evaluation of proposed approach was performed and promising results have been demonstrated when compared with ground truth and other state of art method. The segmented tumor region obtained in our work can assist the doctors and radiologist in the diagnosis of brain tumor and treatment planning.

V. Zeljkovicet.al(2014) The MRI or CT scan images are primary follow up diagnostic tools when a neurologic exam indicates a possibility of a primary or metastatic brain tumor existence. The tumor tissue mainly appears in brighter colors than the rest of the regions in the brain. Based on this observation, an automated algorithm for brain tumor detection and medical doctors' assistance in facilitated and accelerated diagnosis procedure has been developed and initially tested on images obtained from the patients with diagnosed tumors and healthy subjects.
Hayder Saad Abdulbaqiet.al (2014) Brain tumors are created by abnormal and uncontrolled cell division inside the brain.

The segmentation of brain tumors which is carried out manually from MRI is a crucial and time consuming task. The accuracy of detecting brain tumor location and size takes the most important role in the successful diagnosis and treatment of tumors. So the detection of brain tumor needs to be fast and accurate. Brain tumor detection is considered a challenging mission in medical image processing. This paper concerns presenting an approach which will be useful for improved detection of brain tumor using Hidden Markov Random Fields (HMRF) and Threshold methods. The proposed method has been developed in this research in order to construct hybrid

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method. The aim of this paper is to introduce a scheme for tumor detection in Magnetic Resonance Imaging (MRI) images using (HMRF) and Threshold techniques. These methods have been applied on 3 different patient data sets. They have the property of organizing their soothing effect on the final segment of brain tumor homogeneous tissue regions, while the edges between different tissues constituents are better kept.

Stefan Bauer et.al (2012) Image-based modelling of tumor growth combines methods from cancer simulation and medical imaging. In this context, we present a novel approach to adapt a healthy brain atlas to MR images of tumor patients. In order to establish correspondence between a healthy atlas and a pathologic patient image, tumor growth modelling in combination with registration algorithms is employed. In a first step, the tumor is grown in the atlas based on a new multiscale, multiphysics model including growth simulation from the cellular level up to the biomechanical level, accounting for cell proliferation and tissue deformations. Large-scale deformations are handled with an Eulerian approach for finite element computations, which can operate directly on the image voxel mesh. Subsequently, dense correspondence between the modified atlas and patient image is established using no rigid registration. The method offers opportunities in atlas-based segmentation of tumor-bearing brain images as well as for improved patient-specific simulation and prognosis of tumor progression.

Haocheng Shenet.al (2017) Grid conditional random fields (CRFs) are widely applied in both natural and medical image segmentation tasks. However, they only consider the label coherence in neighbourhood pixels or regions, which limits their ability to model long-range connections within the image and generally results in excessive smoothing of tumor boundaries. In this paper, we present a novel method for brain tumor segmentation in MR images based on fully-connected CRF (FC-CRF) model that establishes pairwise potentials on all pairs of pixels in the images. We employ a hierarchical approach to differentiate different structures of tumor and further formulate a FC-CRF model with learned data-driven prior knowledge of tumor core. The methods were evaluated on the testing and leader board set of Brain Tumor Image Segmentation Benchmark (BRATS) 2013 challenge. The precision of segmented tumor boundaries is improved significantly and the results are competitive compared to the start-of-the-arts.

Md. AhasanIbna Aziz et.al (2018) This paper presents a special ultra-wideband (UWB) patch antenna using graphene based conductor (GBC) has been proposed to find human brain tumor. A UWB microstrip patch antenna is designed that consists of radiating element operating at a band from 3.15 - 9.15 GHz. Lengths of ground patch has been considered as the key parameter to achieve optimum antenna performance in terms of reflection coefficient (S11). To detect the brain tumor in human head, a six layered human head model is considered and the proposed antenna is located at 20 mm distance from human head. Brain tumor presence indicated by lower reflection coefficient values compared to higher values recorded by brain tumor absence. The biocompatibility analysis of the head tissue is determined using CST MWS software.

Saroj Kumar Chandra et.al (2019) Brain tumor segmentation in early stage or benign stage is a complex and challenging task. It involves the process of identifying early stage brain tumor cells among normal healthy cells which have approximately similar characteristics or low variation to its surrounding tissues. Many methods have been proposed for benign brain tumor segmentation but most of the methods fails to detect such low variation data. In the present manuscript, fractional model for benign brain tumor segmentation is proposed. The model has higher sensitivity towards low differential data due to arbitrary order of derivative. This arbitrary order of derivative has been exploited to segment brain tumor in early stage. The results obtained have been compared with existing popular methods and it has been found that proposed method is superior among them in brain tumor segmentation in early stage.

Pre-Processing And Segmentation -Pre-processing is used to upgrade standard of MRimages and make it in a form machine understandable system. For improving pre-processing definite parameters ofimages such as signal-to noise ratio, enhancing of MR image, removing noise and unwanted parts from background, smoothing its edges [2]. Author applied adaptive contrast enhancement based on modified sigmoid function [15] for improving signal-to-noise ratio, and clarity of the raw MR images. Segmentation is a process of capturing only interested region from the image. In brain tumour recognition infected cells portion will be our interested region so try to capture that region. In this study, k-mean and Otsu thresholding is used for segmentation of brain MR image
Thresholding-Finally, the best chromosomes set that is obtained is used as the centres points of the cluster, and get final segmented image. After that the thresholding is applied on the segmented image to generate a binary image having two values 0 and 255. A value γ is chosen and every pixel that has intensity value less than γ is made 0 otherwise 255. This operation helps in identifying the region that contains tumour and also helps in extracting it. Hence a binary image I is constructed, where g is original image and γ is threshold value.

$$I(n) = \begin{cases} 0 \text{ if } g(n) \leq \Upsilon \\ 1 \text{ if } g(n) \geq \Upsilon \end{cases}$$

K-Means Clustering-is a partitioning method. The function means partitions data into k mutually exclusive clusters, and returns the index of the cluster to which it has assigned each observation. Unlike hierarchical

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clustering, k-means clustering operates on actual observations (rather than the larger set of dissimilarity measures), and creates a single level of clusters. The distinctions mean that k-means clustering is often more suitable than hierarchical clustering for large amounts of data.

Noise Removal-The noise will occur during MRI scanning and it will lead to over segmentation in tumor detection process. Hence the noise in the image will be segmented as tumor. The purpose of an efficient noise removal method can output a noise free image. Hence the image becomes more distinct. Median filter is used to remove noise from the MRI.

Brain Extraction-Brain skull is a pathological structure and the presence of pathological structures makes it difficult to obtain accurate results. Hence brain extraction used as the pre-processing step for removing the skull from the MRI. The thresholding techniques and the morphological operations are used for extracting the brain from the MRI [19][18]. Thresholding is done based on the histogram of the image. Open and dilation are used for morphological operations.Shows the processes in brain extraction method.

Morphology:is a broad set of image processing operations that process images based on shapes. In a morphological operation, each pixel in the image is adjusted based on the value of other pixels in its neighborhood. By choosing the size and shape of the neighborhood, you can construct a morphological operation that is sensitive to specific shapes in the input image.J = imopen(I,SE) performs morphological opening on the grayscale or binary image I, returning the opened image, J. The proposed system uses the Discrete Wavelet Transform (DWT) coefficients as feature vector.

The wavelet is a powerful mathematical tool for feature extraction, and has been used to extract the wavelet coefficient from MR images. The main advantage ofwavelets is that they provide localized frequency information about a function of a signal, which is particularly beneficial for classification. coeff = pca(X) returns the principal component coefficients, also known as loadings, for the n-by-p data matrix X. Rows of X correspond to observations and columns correspond to variables. The coefficient matrix is p-by-p. Each column of coeff contains coefficients for one principal component, and the columns are in descending order of component variance. By default, pca centers the data and uses the singular value decomposition (SVD) algorithm .

Types of kernel SVM used::Kernel Support Vector Machine in machine learning, kernel methods are class of algorithms for pattern analysis, whose best known member is the support vector machine (SVM). This results high accuracy, mathematical tractability and geometrical interpretation [2]. In areas this support vector machines works effectively majority areas like image processing, neural networks, fuzzy logic, and networks classification. This also works for other parameters that involve convex quadratic optimization algorithms

- Linear kernel SVM
- RBF kernel SVM
- Polygonal kernel SVM
- Quadratic kernel SVM

Discrete Wavelet Transform- The image is spited into a sequence of wavelets that can be retained better than the pixel blocks. Discrete Wavelet Transform (DWT) is an application in which time and frequency information of the signal is examined. Discrete Wavelet Transform is a linear transformation that operates on data vector, having length with integer power of two. Discrete Wavelet Transform is characterized by a maximal number of disappearing moments. This 2D Discrete Wavelet Transform intends to decay the applied input image into an approximation coefficients (cA) and detailed coefficients like cH, cV and cD (horizontal, vertical and diagonal) obtained SVMFor a given a training set, the support vector machine using Equation 3, constructs a hyper plane as the decision surface in order to separate the negative and positive classes such that the margin of separation of the hyper plane is maximised.

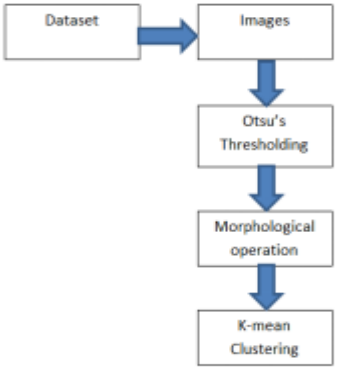

Fig.3 pre-processing and segmentation flow chart.

Feature Reduction Extreme features increase the manipulation diagnosis time and memory space. To order to reduce the size of extracted feature PCA (principle component Analysis) is used. PCA is an effective algorithm to reduce the dimension of dataset. When it is given to the huge amount of interrelated variable data set which can retains its variations. The content available in the data set transforms to a new set of ordered variables depends on the variances.

The technique affects indifferent ways: it orthogonalizes the given input vectors hence it uncorrelated to each other with the available component. From the result of orthogonal components, the components having maximum variations only considering and components with minimum variations are eliminated from the data set.

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While applying PCA the input vectors must be valued as zero mean with unit variance to meet the normalization standard procedure. The feature extracted matrix B is transformed into reduced vector by using principle component Analysis. The algorithm involved in principle component Analysis is The feature extracted matrix with the size m × n will be the input.Finding the value of mean, μ ifor all dimensions. To obtain a new matrix A, mean centreB is subtractingμ ifrom each column of i. Find the covariance matrix C with the size of n × nObtain both eigenvectors and eigenvalues of C To get reduced feature vector sort the eigenvalues.

IV. CONCLUSION

The proposed hybrid approach was applied to brain MRI Images in order to classify brain tumor either as benignant or malignant. Automatic brain tumor detection approach reduces the manual labeling time and avoids the human error.This approach the Support Vector Machine has been used for the classification of MR images In future, an enhancement can be further done for optimizing the accuracy. This paper will be proposed a novel methodology for classifying the brain tutor dataset into Malignant and benign type.

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