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A Survey on an Effective Identification and Analysis for Brain Tumour Diagnosis using Machine Learning Technique

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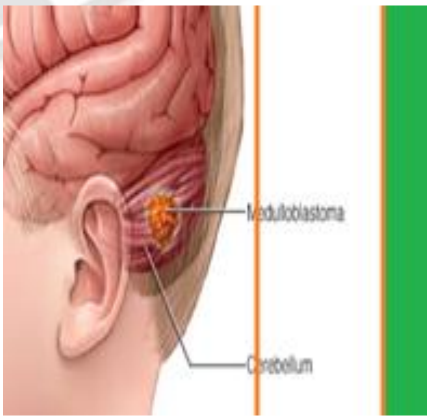
Abstract: The hottest issue in medicine is image analysis. It has drawn a lot of researchers since it can effectively assess the severity of the condition and forecast the outcome. The noise trimming outcomes, on the other hand, have reduced with more complex trained images, which has tended to result in a lower prediction exactness score. So, a novel Machine Learning prediction framework has been built in this present study. This work also tries to predict brain tumours and evaluate their severity using MRI brain scans. Using the boosting function, the best results for error pruning are produced. The Proposed Solution function was then used to successfully complete the feature analysis and tumour prediction operations. The intended framework is evaluated in the Python environment, and a comparative analysis is performed to examine the prediction improvement score. It was discovered that an original MLPM model had the best tumour prediction precision.

Keywords: Brain tumour prediction; feature analysis; severity analysis; Machine learning; prediction accuracy.

I. INTRODUCTION

In a human biological system, the brain tumour is considered a harmful disease category [1]. Hence, the early tumour diagnosis framework is a major concern in recovering human lives with proper treatment procedures [2]. Several medical analysis tools exist for these diagnosis systems [3]. However, those tools are high in cost also that is not suitable for predicting all tumour types [4]. Considering these drawbacks, intelligent models have been introduced for the disease prediction problem, which functioned as a neural model [5]. The neural framework process without the optimum layer is defined as machine learning (ML) [6]. Also, the neural models processed with optimal layers for the tuned prediction outcome are termed deep learning (DL) networks [7]. However, the neural models have needed more periods to train the system [8]. Furthermore, the imaging analysis was introduced to the medical framework for the finest visualization results [9]. Some imaging schemes have required more image features to train the system that has maximized the complexity score of the imagining system [10]. A brain tumour might start in the brain cells (as depicted in figure-1) or it can start somewhere else and spread to the brain. As the tumour grows, it places pressure on and alters the function of nearby brain tissue, resulting in headaches, nausea, and balance issues.

Fig-1 Brain Tumor representation-1



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A brain tumour is a grouping of abnormal brain cells. There are numerous types of brain tumours. Some brain tumours are noncancerous (harmless), whereas others are cancerous (malignant). Brain tumours can start in the brain (primary brain tumour) or spread to the brain from other parts of the body (metastatic brain tumor).

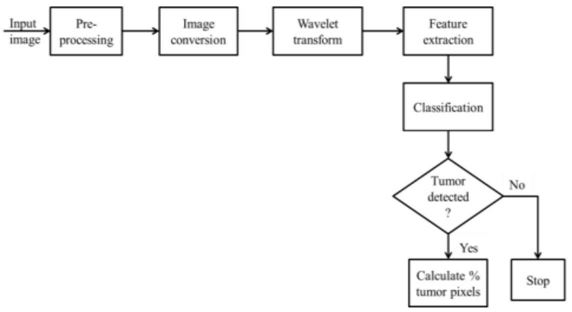

Fig-2 Brain tumor representation-2 and Overall representation

Moreover, the critical contribution steps of the designed prediction system are described as follows,

Table-1 Symptoms of Brain tumor

Symptoms	Types of Tumors
A new migraine attack or a change in headache pattern	Gliomas.
Headaches that worsen and grow more frequent over time	Meningiomas.
The reason of nausea or vomiting is unknown.	Acoustic neuromas
Vision difficulties such as decreased vision, double vision, or peripheral vision loss	Pituitary adenomas.
Gradual loss of sensation or mobility in an arm or leg	Medulloblastomas
Issues with Equilibrium	Germ cell tumors
Difficulties speaking	Craniopharyngiomas
I'm completely exhausted.	
Confusion in everyday life	
It is difficult to make decisions.	
Inability to adhere to simple directions	
Personality or behavior changes	
Seizures, especially in someone who has never had seizures before	
Hearing problems	

The signs and symptoms of a brain tumour vary greatly depending on the tumor's size, location, and rate of growth.
The signs and symptoms of a brain tumour vary greatly depending on the tumor's size, location, and rate of growth.
A new migraine attack or a change in headache pattern
Classical Machine Learning Techniques: To name a few, numerous brain diagnostic systems have been built utilising classical ML techniques such as Support Vector Machines (SVMs), Random Forests (RFs), and k-Nearest Neighbour (k-NN). These methods can be used alone or in conjunction with other machine learning algorithms or feature selection approaches. This section provides an overview of machine learning-based brain classification and segmentation algorithms.

- ❖ Initially, the brain MRI images have been gathered and considered as the input of the designed model
- ❖ Then a novel MLPM was built with sufficient boosting and prediction features
- ❖ Henceforth, pre-processing has been performed to neglect the noise features from the trained data
- ❖ Consequently, a feature analysis process has been executed to identify and extract the meaning of features
- ❖ Finally, the tumour region has been tracked and detected by matching the testing image features with the trained, healthy brain image features
- ❖ Subsequently, the parameters were measured based on time, error rate, prediction accuracy, F-value, recall, and precision.

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SNO	Paper Title	Methodology	Dataset	Publisher Name and Year	Accuracy of Results	Advantage	Limitations	Social Benefit
1	A novel framework for brain tumor detection based on convolutional variational generative models	A novel generalized framework for brain tumors detection and classification. The proposed framework used two different deep models for two different tasks.	Chakrabarty N (2019) Dataset for brain tumor MRI images	Springer March 2022	CNN – 90.62% TransferLearning – 93.75% Proposed Framework – 96.88%	Obtaining such data is usually boring, time-consuming, and can easily be exposed to human mistakes which hinder the utilization of such deep learning approaches	----	Brain Tumor Detection
2	Optimization empowered hierarchical residual VGGNet19 network for multi-class brain tumour classification	The proposed Square Array Filtering(SAF) approach is applied to the acquired input image in order to remove such noisy contents		P. Rama Krishna1 & V. V. K. D. V. Prasad2 & Tirumula Krishna Battula1 September 2022	98%			
3	A Novel Approach for Automatic Brain Tumor Detection Using Machine Learning Algorithms	Automatic detection of brain tumor using machine learning algorithms and its early detection of risk factors using nano-robotic health care systems is a challenging and novel approach.		Madhuri, G. S., Mahesh, T. R., & Vivek, V. (2022).	96%			
4	Predictive modeling of brain tumor: a deep learning approach. In: Innovations in computational intelligence and computer vision,	This paper presents a convolution neural network (CNN)-based transfer learning approach to classify the brain MRI scans into two classes using three pre-trained models.	Local Data Sets	Saxena P, Maheshwari A, Maheshwari S (2021)	Experimental results show that the Resnet-50 model achieves the highest accuracy and least false-negative rates as 95% and 0, respectively. It is followed by VGG-16 and Inception-V3 model with an accuracy of 90% and 55%, respectively.			Image processing concepts can visualize the different anatomy structure of the human body.
5	Brain tumor classification	proposed model by adopting the	CE-MRI dataset	Soumik MFI,	99%	we propose 3-class deep learning	precision, recall, F-	

	with inception network based deep learning model using transfer learning.	concept of transfer learning uses a pre-trained InceptionV3model extracts features from the brain MRI images and deploys softmax classifier for classification.		Hossain MA (2020) In: 2020 IEEE Region 10 Symposium (TENSYMP)		model for classifying Glioma, Meningioma and Pituitary tumors which are regarded as three prominent types of brain tumor.	score are also considered while assessing the performance	

II. SAMPLE SYSTEM MODEL WITH PROBLEM DESCRIPTION

The imaging system has been widely utilized in medical applications to visualize the disease features with more possible clarity. However, few demerits in the imaging framework have degraded the prediction system. Hence, the usual imaging system with the described problem is defined in fig.1.

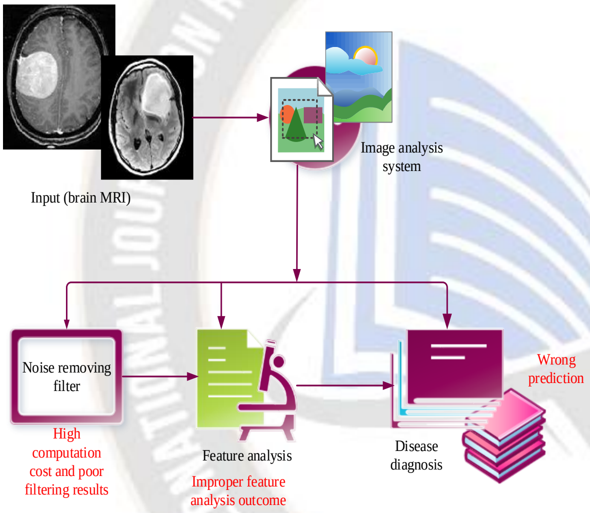

Fig.3 conventional tumour prediction system with problems

III. PUBLICKELY AVAILABLE DATSETS FOR BRAIN TUMOR

The symptoms and indicators of a brain tumour may differ significantly depending on the tumor's size, location, and pace of growth. a new migraine attack or an increase or decrease in headache frequency. A collection of data is referred to as a data set or dataset. A data set in the context of tabular data refers to one or more database tables, where each row denotes a specific record from the data set in question and each column denotes a specific variable. Values for each variable, such as an object's height and weight, are contained in the data set for each set member. A data set can also be thought of as a collection of files or papers.

Table -2 Following table shows Dataset Details:

Sno	Dataset Name and Posted on	Source	Author
1	Brain tumor dataset 03-04-2017	Figshare	Jun Cheng
2	Brain MRI Images for Brain Tumor Detection	Kaggle	Navoneel Chakrabarty
3	Brain Tumor Dataset-Thu, 07/01/2021	IEEE-DATAPORT	Radhamadhab Dalai

IV. SIMILAR LITERATURE REVIEW

Some of the recent literature related to brain tumour diagnosis has been described as follows:

Amin *et al.* [11] proposed the Fused Feature Vector Method to diagnose a brain tumour. In this method, the input data was enhanced by the Weiner filter's removal of noise using several wavelet bands. Then, using Potential field (PF) clustering, isolate subgroups of tumour pixels. Then, in the T2 MRI and Fluid Attenuated Inversion Recovery, isolate the tumour location using a range of global thresholds and mathematical techniques. Finally, the Gabor Wavelet Transform (GWT) and Local Binary Pattern (LBP) efficiently discriminated various forms of brain cancers. However, segmenting the brain tumour requires additional time.

Manogaran *et al.* [12] presented an improved orthogonal gamma distribution-based machine learning system for analysing the over and under-segmented brain tumour regions to detect the faulty function in the Region of Interest (ROI). This technique was used to calculate the tissues edge enhancement and organise the matching done by the orthogonal gamma distribution. Then, estimate the variance for the edge detection from the enhanced image. Due to high noise and cluster sensitivity issues, it was difficult to segment the brain tumour.

Brunese *et al.* [13] discussed the Ensemble Learning technique was utilised to locate brain tumours having radiomic features. The ensemble learner is dedicated to insight into the brain tumour grades by noninvasive radiomic features. This considered feature belongs to five groups. Finally, once the effectiveness of the features had been evaluated by hypothesis

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testing and decision boundaries, the best classifier for the ensemble learner to segment the brain tumour was selected. This method requires increasing the diagnosis accuracy of brain tumours.

Rehman *et al.* [14] suggested Brain tumour Localization technique was used to recognize brain tumours from MR images. Initially, apply the bilateral filtering to remove the noise and create the text on the map using the Gabor filter. The low-level features were then recovered from the images after they had been split from the map's text. The text's histogram level was then determined for each super pixel level on the map. Finally, three classes—background, tumour, and non-tumour region were predicted by the classifier. The image quality in image processing, however, was inadequate for identifying a brain tumour.

Kang *et al.* [15] proposed a group of machine learning classifiers and deep features for the classification of brain tumours. The original method consists of three steps: Pre-trained CNN models were used to extract the deep features in order to retrieve meaningful information. Then, the features were selected by fined-tuned ML models and combined with the ensemble model for obtaining the brain tumour classification from brain MRI. However, it occurred due to the time complexity involved in segmenting the brain tumour result.

Haq, E.U., et all [16] Presented an When used in conjunction with data augmentation techniques, the intensity normalisation approach is also examined as a pre-processing step and shows exceptional results in the identification and classification of brain tumours. There were 3062 and 251 pictures in the Figshare and BraTS 2018 collections, respectively. The experimental results show that while the second proposed CNN architecture correctly identified 96.5% of glioma grades as HGG or LGG, the first proposed CNN architecture correctly identified 97.3% of brain tumours as gliomas, meningiomas, or pituitary tumours and had a dice similarity coefficient (DSC) of 95.8%. Experimental findings show that our suggested model beats state-of-the-art techniques in terms of effectiveness and classification accuracy.

A popular technique for high-quality medical imaging is magnetic resonance imaging. An advanced medical imaging method known as magnetic resonance imaging (MRI) can reveal detailed information on the structure of soft tissues in humans. Edge detection, object segmentation, noise suppression, and many other applications have all benefited from the widespread use of mathematical morphology, which offers a methodical approach to analysing the geometric properties of signals or images. Using image segmentation, different elements of the image are extracted and then combined or split to create objects of interest, on which analysis and interpretation can be done. The paper's main objective is to apply mathematical morphology to identify brain tumours and cancer cells in MRI images.

The processing of images obtained from magnetic resonance imaging (MRIs) is one of the most recent developments in the field of medical image processing. This study's primary goal is to identify and extract brain tumours from magnetic resonance scanning images.

This research was creating a graphical user interface with MATLAB to extract the brain tumour from an MRI scan. Image. grayscale conversion of the original image, noise removal, morphological processing, and segmentation. During coding, the threshold and region-growing techniques were used. The 56 chosen brain tumours were all tested. The remaining 5.36% (3) were only partially detected, while around 94.64% (53) were correctly detected.

V. MACHINE LEARNING TECHNIQUES FOR BRAIN TUMOUR PREDICTION

A novel MLPM-based Boosting Multilayer Perceptron MLPM has been designed as a disease prediction model in this current research solution. The database that was taken to validate the success score of the built model is brain MRI images. Hence, different kinds of brain MRI images as been gathered and imported into the system. Consequently, a novel proposed framework has been built to analyse the image features and forecast the disease-affected region. Primarily, the filtering function was processed to eliminate noisy features, then the refined data was imported to the classification phase for the feature analysis, and then the disease diagnosis function was performed. The proposed design is explained in fig.2. Brain tumours are cancerous tumours that have spread throughout the brain. They are classed as benign (non-cancerous) or malignant (cancerous) based on their aggressiveness, and are further classified into four classifications using the WHO classification for Central Nervous System.

Tumor of the central nervous system (CNS) that range in malignancy from 1 to 4. Meningiomas and pituitary tumours, for example, seldom spread to healthy cells.

Brain Tumor Detection using SVM:

Magnetic Resonance Imaging (MRI) is a common non-invasive technique. Magnetic Resonance Imaging (MRI) is a non-invasive technology used in medicine to examine, diagnose, and treat brain structures. An early diagnosis of a brain tumour can assist preserve a patient's life by providing sufficient therapy. Cancer detection in MRI slices becomes a difficult work; as a result, this proposed method can accurately categorise and segment the tumour region. Tumor detection from an MR image is employed in segmentation and 3D reconstruction as well. In order to save time, doctors' manual tracing and visual examination will be reduced. SVM Classifier is used to localise

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a mass of aberrant cells in a slice of Magnetic Resonance (MR) and tumour cell segmentation to assess the amount of the tumour present in that segmented area. The collected properties of the segmented area will be taught to an artificial neural network to display the type of tumour. These characteristics will also be used to compare the accuracy of different classifiers in the Classification Learner app. The scope of this research is beneficial in post-processing of the retrieved region, such as tumour segmentation.

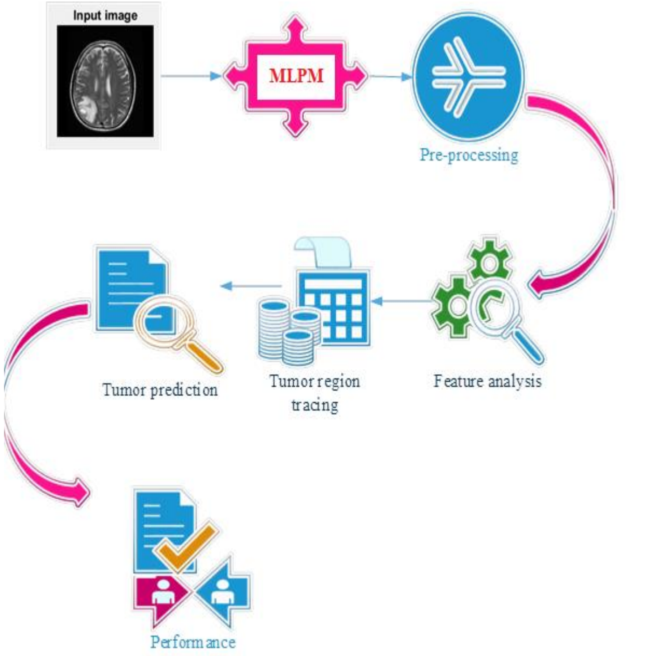

Fig.4 proposed methodology: MLPM

Magnetic Resonance Imaging is a common non-invasive technique. The segmentation of gathered images, which defines the boundaries of objects such as abnormal regions or organs, is one of the most difficult challenges in medical analysis. The segmentation method yields useful tumour region parameters such as area, eccentricity, bounding box, and orientation.
The following factors are used to segment images: threshold, edge, pixels, cluster, and neural network.
Morphology is the form-based processing of pictures.
When a structuring element is applied to a pre-processed input image, an output image of the same size is produced. Every pixel in the input image is compared to its neighbours, and the results are the values of the corresponding output pixel.

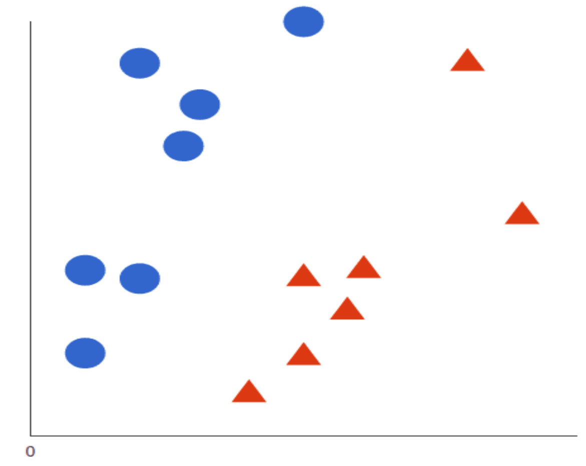

Fig-5 SVM Binary Classification

Magnetic resonance imaging is a well-liked non-invasive method (MRI). Magnetic resonance imaging (MRI) is a common non-invasive imaging technique (MRI). Magnetic resonance imaging (MRI) is a well-liked non-invasive imaging technique (MRI). The SVM then determines which hyperplane efficiently separates the tags. There is just one dimension to this line. On one side of the line, everything is blue, while on the other, it is all red. This may be both helpful and harmful in sentiment analysis.

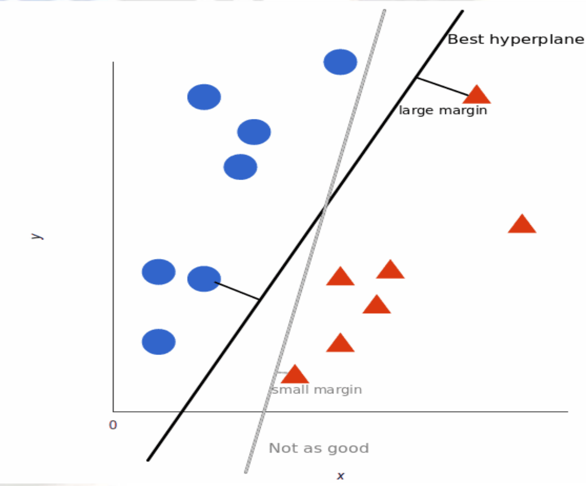

Fig-6 SVM Classification

The SVM then determines which hyperplane best separates the tags. This is a one-dimensional line. Everything on one side of the line is red, while everything on the other is blue. This could be both positive and negative in sentiment analysis.
For machine learning, the hyperplane with the greatest distance between each tag is the best:
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A support vector machine (SVM) is a machine learning algorithm that goes beyond X/Y prediction by using algorithms to train and categorise data within degrees of polarity.
In order to provide a basic visual example, we'll use two tags: red and blue, as well as two data features: X and Y, and then train our classifier to output an X/Y coordinate as red or blue.

Methodology and sample problem model:
Consequently, initialize the data in the training phase. Pre-processing, feature extraction, segmentation, and classification were the four steps in the segmentation process for brain tumors. In pre-processing stage, there would be noise in the data then removed from the data by using the filter. The feature was then extracted using the data that had been subjected to noise removal as the input. Then, segmentation and classification were determined using the optimized process. Brain tumor segmentation was needed to predict and segment the brain tumor accurately.

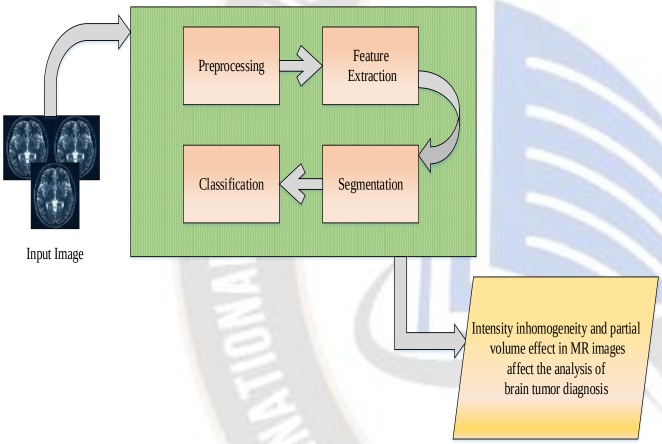

Fig.7 System Model with Problems

The analysis of brain tumors is impacted by artefacts including intensity inhomogeneity and partial volume effect in MR images. Then, define the system model in the segmentation of brain tumor application in fig.1.

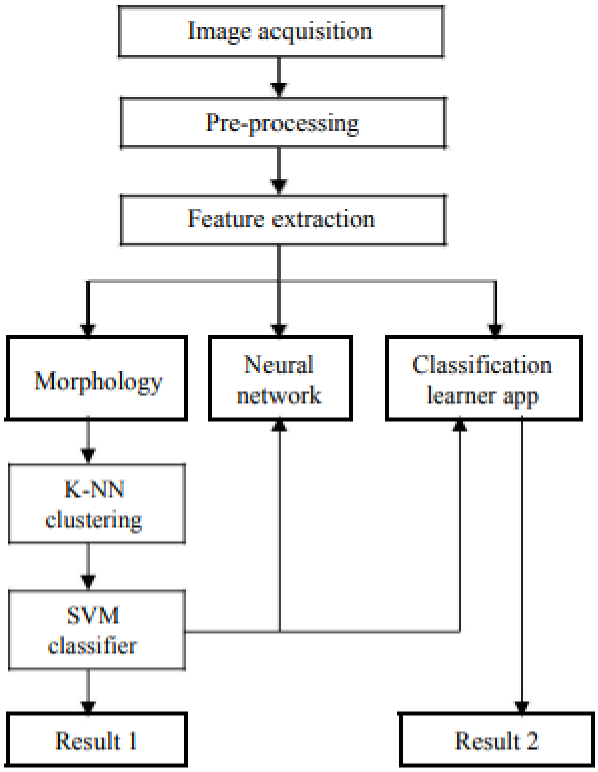

Fig-7 Overview of Sample Proposal

SAMPLE PROPOSED Tbsvm FOR BRAIN TUMOR DIAGNOSIS:
This study performed a procedure of diagnosing brain tumor condition. The development of a novel Tiger-based Support Vector Machine (TbSVM) method to distinguish the brain tumor's location from the MR images was a key objective of this diagnosis approach. This process involves four stages: pre-processing, feature extraction, prediction, and segmentation. Initially, the unnecessary noise was removed from the input image by the wiener filter. Next, the feature used in the extraction process was GLCM features, with the help of the tiger fitness feature; extract the features for prediction and segmentation. The tumor and normal region could be segmented through the proposed TbSVM model.

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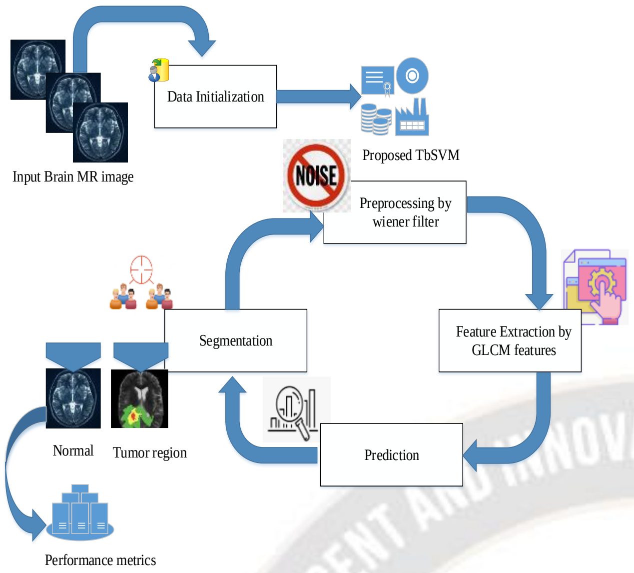

Fig. 8 The basic diagram of Proposed TbSVM

The dataset used in the suggested strategy for the diagnosis of the brain tumor disease was the Brain Tumor MRI Dataset. This dataset includes the whole segmentation of brain tumor disease using MRI data. Fig. 2 defines the novel framework that is being presented.

5.1 Preprocessing

Brain MRI data was determined as S the dataset training process was described $F(S)$ and $\{S_1, S_2, S_3, \ldots, S_n\}$ denoted as the trained n amount of data. The data initialization process is exposed in Eqn. (1).

$$F(S) = \{S_1, S_2, S_3, \ldots, S_n\} \tag{1}$$

Preprocessing was the first stage of the segmentation procedure for brain tumors. In this case, the wiener filter would inverse the blurring while also removing the noise. Use this filter as part of the preprocessing to eliminate unwanted noise features. The preprocessing function is indicated in Eqn. (2)

$$P = \mu + \frac{\sigma^2 - \sigma_n^2}{\sigma^2}[g(s,t) - \mu] \tag{2}$$

Where, P represented as the preprocessing variable, σ and μ denoted as the mean and variance for the input images, $g(s,t)$ represented as the pixel value of the image. Then, use the wiener filter to get higher efficiency for removing the impulse noise in the preprocessing stage.

5.2 Feature Extraction

The necessary step in brain tumor segmentation was feature extraction. In this research, the input for this stage was the noise removal data that aimed to extract the feature. Here, the GLCM feature was extracted for the feature extraction process using the fitness features of the Tiger algorithm [29]. In tiger algorithm, the Tiger (input images) sees its food source (GLCM feature), and it gets its food source with the help of its claw (fitness function). The input image and food source comparison are based on estimating the fitness value in Eqn. (3).

$$D(x) = D_i / x^2 \tag{3}$$

Here D_i was the distance coefficient between the food source and the Tiger, x was the distance between the food source and the input images, $D(x)$ represented as the comparison between the input images and food source also, η defines the absorption coefficient among the food source and the input images and their formulation in Eqn. (4).

$$D = D_0 e^{-\eta x} \tag{4}$$

Where D_0 denoted as the coefficient of the direct distance between a food source and the input image. To avoid zero division, use a formula with Gaussian approximation. Then, calculate the fitness function between the tigers i and j x_i x_j and find the best solution in Eqn. (5).

$$FF = |x_i - x_j| = \sqrt{\sum_{k=1}^{d}\left(x_{i,k} - x_{j,k}\right)^2} \tag{5}$$

The feature extraction process was earned by the proposed model, which was detailed in Eqn. (6).

$$E = P + \phi_0 Feature(S_n) \tag{6}$$

Where P denoted as the Preprocessing variable $feature(S_n)$ represented the number of features in the dataset, determine the monitoring process variable was ϕ_0, and the feature extraction parameter was defined E.

5.3 Prediction and Segmentation

After completing the feature extraction process, the prediction and segmentation process was performed. The Support Vector Machine (SVM) classifier should then be provided with the retrieved characteristics to determine whether the MR images are normal or tumor. If brain tumor was present, segment the tumor region using the TbSVM model. Hence, the disease-affected region had been determined by Eqn. (7).

$$\Pr = E + \sum_{i=1}^{n}(A_i, Nb_i) \tag{7}$$

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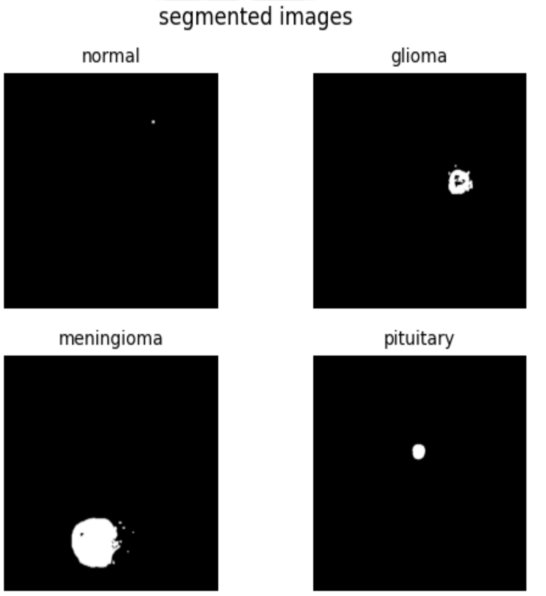
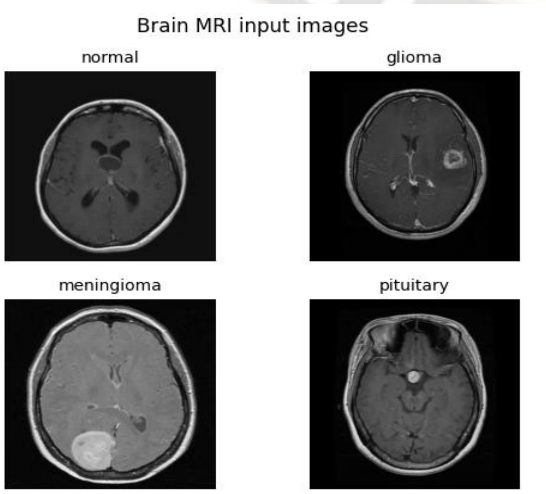
Here, the extracted feature was defined as E, Nb_i the normal MRI brain images, A_i denoted as the abnormal brain MRI image, and $\Pr$ was the prediction process. Here, execute the prediction process in the image region to recognize whether it had a brain tumor in Eqn. (8).

$$Segmentation = \begin{cases} \Pr \leq 0 & Tumor\ region \\ \Pr \geq 1 & normal\ region \end{cases} \quad (8)$$

Hence, if the predicted region was less than equal to 0, then segment the tumor region. If the prediction region was greater than equal to 1, then the region was not affected by the tumor, which was normal.

The Python tool tested the proposed TbSVM technique on the Windows 10 platform. The dataset considered for this research was Brain Tumor MRI Dataset, which includes normal and affected region images. Also, consider that this present study's training and the testing percentage is 80% of training and 20% of testing.





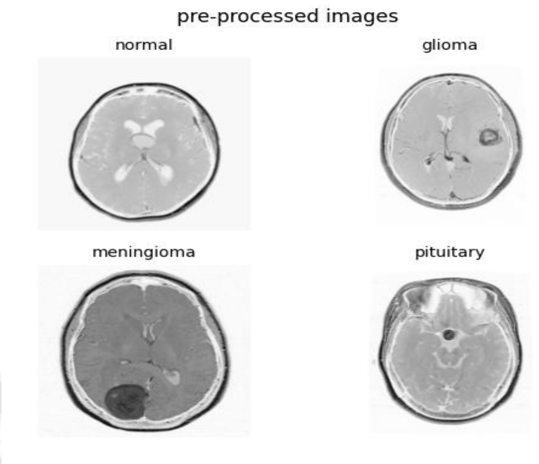


Fig-8 Sample results

Table.4. Parameter specification

Operating system	Windows 10
Programming platform	Python
Version	3.7.6
Database	Brain Tumor MRI Dataset

KNN

Tumor cell characteristics are easily extracted from an MRI image and analysed by a classifier system. In this study, KNN is used to compute the area occupied by a brain tumour. Low pass and high pass filters, as well as morphological procedures like dilation and erosion, effectively

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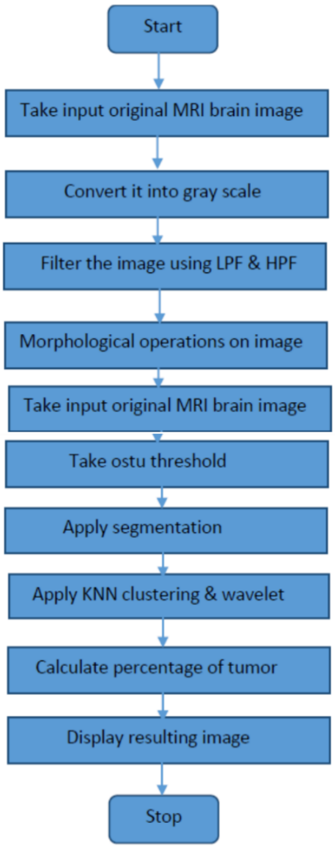

Fig-10 KNN Representation

eliminate noise. To acquire good MRI imaging findings, Scope MRI brain Tumor will be diagnosed using Learning algorithms.

VI. Conclusion

Magnetic Resonance Imaging (MRI) is a common non-invasive technique. Magnetic Resonance Imaging (MRI) is a popular non-invasive imaging technology. Brain tumour identification remains difficult due to tumour appearance, fluctuating size, shape, and structure. Although tumour segmentation algorithms have shown significant promise in detecting and analysing tumours in MR images, much more research is required to accurately segment and classify the tumour region. Existing research has limitations and challenges in identifying tumour substructures and distinguishing healthy and unhealthy images.

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