Deep Learning Approach for Brain Tumor Classification using SVM

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Abstract: *Object detection plays a major role in many areas like medical imaging, aerial surveillance, optimal manipulation and analysis, surgical microscopes, etc. The objective of this paper is to develop a model for brain tumors detection and classification i.e., to classify whether the tumor is cancerous or non-cancerous using SVM algorithm. Earlier many have detected using ANN which works on Empirical Risk Minimization. We are using Support Vector Machine algorithm that works on structural risk minimization to classify the images. The SVM algorithm is applied to medical images for the tumor extraction, and a tumor classification function. This paper presents a prototype for SVM-based object detection, which classifies the images and evaluates whether the classified image is cancerous or non-cancerous.*

Keywords: Image processing, SVM, MRI(magnetic resonance imaging), brain tumor

I. INTRODUCTION

Brain tumors are the most common issue in children. Approximately 3,410 children and adolescents under age 20 are diagnosed with primary brain tumors each year. Brain tumors, either malignant or benign, that originate in the cells of the brain. Brain tumor detection and segmentation in magnetic resonance images (MRI) because it provides information associated with anatomical structures as well as potential abnormal tissues necessary to treatment planning and patient follow-up. The segmentation of brain tumors can likewise be useful for general demonstrating of neurotic brains and the development of obsessive cerebrum brain atlases.

Upgrades in database innovation, figuring execution and man-made brainpower have added to the improvement of clever information investigation.

The support vector machine has been created as a hearty apparatus for order and relapse in loud, complex spaces. Not at all like conventional strategies which limit the observational preparing mistake. Bolster vector machine goes for limiting an upper bound of the speculation mistake through amplifying the edge between isolating hyper plane and the information. This can be viewed as a surmised usage of the Structure Risk Minimization guideline.

By picking various types of bits, bolster vector machine can understand Radial Basis Function (RBF), polynomial, straight, and multi-layer preceptor classifiers. Many different types of brain tumors exist. Some brain tumors are noncancerous (benign), and some brain tumors are cancerous (malignant). Brain tumors can begin in your brain (primary brain tumors), or cancer can begin in other parts of your body and spread to your brain as secondary (metastatic) brain tumors.

Medical imaging as magnetic resonance image (MRI) is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention. Main advantages of MRI over CT scan are, MRI provides more accurate visualize of anatomical structure of tissues and it does not contain any radiation effects. Therefore, it is widely used for brain imaging.

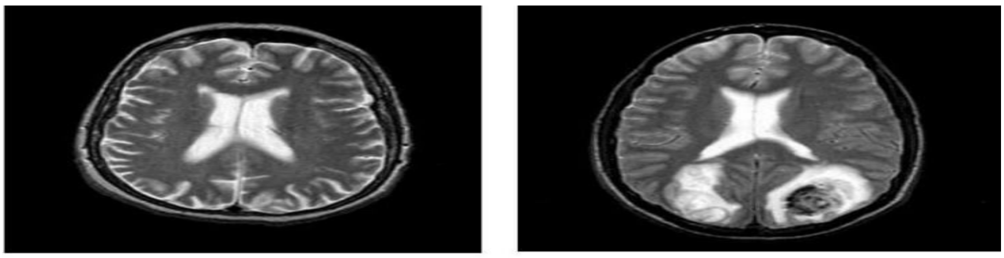
The brain is one of the most complex mechanisms in the human body, made up of billions of cells. A brain tumor can be expressed as a tissue that occurs in a place where it should not be in our brain or an uncontrolled growth of any tissue where it should not be. Early and correct detection of brain tumor has a very important place in this type of cancer, which is fatal. In this study, the classification process was carried out using MRI images. Networks must be trained with large databases before this process can be done. In this paper, deep learning methods are used which can produce successful results in large data- bases. Thanks to computer-aided systems, experts can diagnose the disease. In this way, mistakes that may arise in traditional methods are prevented. There are studies in the literature using different models and architectures.

The brain tumor detection from MRI images schemes works on either coefficient of transformed domain or spatial values of an image. Classification of brain MRI images play vital role for analysis and interpretation of brain diseases. Many methods have been proposed to design accurate classifier to distinguish normal and abnormal brain MRIs.

Feature extraction is a prominent process to classify brain MRIs. The extraction of feature means reduces the dimensionality of input image and transform the simplified set of data for calculation. The process of feature extraction eliminates redundant data by measuring certain image properties. The extracted features provide relevant properties of the image into feature vectors and distinguish one pattern into another pattern

Image segmentation technique is applied to brain MRI for partitioning the image into meaningful simplified regions have similar attribute or feature. The features used for segmentation largely depend on the process of feature extraction. The image intensities are most common feature for tumor segmentation of brain MRIs. Segmentation can easily distinct infected region of the brain by grouping the image pixels based on the intensity level.

Our main contribution of this work is to develop an improved feature extraction-based classification method for brain MRI images which can identify the abnormalities of the brain. The proposed method, firstly, applies the basic segmentation technique. Next it introduces a log-polar transform-based feature extraction method along with classification algorithm to detect the brain tumor. The scheme, thereafter, classifies the abnormal brain images and records them as benign and malignant tumor.



BENIGN **MALIGNANT**

Fig 1.1: MRI scans of a benign and malignant brain tumor

In this project, firstly we apply the basic segmentation technique and then introduce a log- polar transform-based feature extraction method along with classification algorithm which can detect the brain tumor and classify the tested brain primarily into two categories: normal and abnormal as well as benign and malignant tumor for abnormal brain. Our main objective of this thesis is to develop an improved classification method based on feature extraction process for brain MRI images which can identify the abnormalities of brain.

The accurate segmentation of brain MRI images is necessary for detecting any abnormalities in MRI images as well as to diagnose them correctly. The segmentation process selected abnormal brain MRI images randomly from our image dataset. The image dataset contains neoplastic and degenerative diseases: Glioma, Meningioma, Sarcoma, Alzheimer's disease, Huntington disease, Picks disease and Alzheimer's disease plus visual agnosia. The scheme then categorizes the abnormal brain images with a probability of having cancer tissues. Nevertheless, a benign brain tumor is a non-cancerous mass of cells that grow relatively slowly in the brain and tends to remain constant in one place. An appropriate surgery can remove a benign tumor safely.

In that case the patient usually experiences a radiotherapy or chemotherapy to kill the cancerous cell.

II. LITERATURE SURVEY

Parveen, Amritpal singh [2] purposed algorithm is a combination of SVM and fuzzy c-means, a hybrid technique for prediction of brain tumor. Here, the image is enhanced using contrast improvement, and mid-range stretch. Double thresholding and morphological operations are used for skull striping. Fuzzy c-means (FCM) clustering is used for the image segmentation. Grey level run length matrix (GLRLM) is used for extraction of feature. Then, Linear, Quadratic and Polynomial SVM technique is applied to classify the brain MRI images. Real data set of 120 patients MRI brain images have been used to detect 'tumor' and 'non-tumor' MRI images. The SVM classifier is trained using 96 brain MRI images, after that the remaining 24 brain MRI images was used for testing the trained SVM. SVM classifier with

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Linear, Quadratic and Polynomial kernel function give 91.66%, 83.33% and 87.50% accuracy respectively and 100% specificity.

Astina minz, Prof. Chandrakant Mahobiya [8] proposed an effective automatic classification method for brain MRI is projected using the Adaboost machine learning algorithm. The proposed system consists of three parts such as Preprocessing, Feature extraction and Classification. Preprocessing has removed noise in the raw data, it transform RGB image into grayscale, median filter and thresholding segmentation is applied. For feature extraction by using GLCM technique 22 features were extracted from an MRI. For classification boosting technique used (Adaboost). It gives 89.90% accuracy and result in normal brain or in Malignant or Benign type of tumor. In future work, we can work of quadratic and polynomial kernel function. The accuracy of the system will be increased by increasing training database images. Also the system can be implement for different types of classes like Glioma and Meningioma.

Garima Singh, Dr. M.A. Ansari[9] proposed, a novel technique which includes Normalization of Histogram and K-means Segmentation. First, input image is pre-processed in order to remove the unwanted signals or noise from it. To de-noise filters such as Median filter, Adaptive filter, Averaging filter, Un-sharp masking filter and Gaussian filter is used in the MRI images. The histogram of the pre-processed image is normalized and classification of MRI is done. Finally, the image is segmented using K-means algorithm in order to take out the tumor from the MRI. Efficient classification of the MRIs is done using NB Classifier and SVM so as to provide accurate prediction and classification. Naive Bayes and SVM Classifier give accuracy 87.23% and 91.49% respectively. SVM give better classification accuracy. For implementation MATLAB is used. The proposed method has some limitations that it could not find out the precise or accurate boundary of the tumor region. In the future, improvement in the proposed algorithm can be done by working on the limitations, the quality of the output images can be improved by using better morphological operations.

G Rajesh Chandra, Dr. Kolasani Ramchand, H Rao [4] proposed method in that MRI image of brain is de-noised using DWT by thresholding of wavelet co-efficient. Genetic algorithm is applied to detect the tumor pixels. A genetic algorithm is then used in order to determine the best combination of information extracted by the selected criterion. The present approach uses k-Means clustering methods into Genetic Algorithms for guiding this last Evolutionary Algorithm in his search for finding the optimal or sub-optimal data partition. This method achieved segmentation accuracy from 82 percent to 97 percent of detected tumor pixels based on ground truth. The limitation of this work is that wavelet transform require large storage and its computational cost is high.

Mukambika P. S., Uma Rani K. [1] Proposed Methodology in which Image is processed through: Preprocessing, Segmentation, Feature extraction Classification stages. In preprocessing, Morphology technique using double thresholding is applied to remove the skull out of the MRI brain images. The present work presents the comparison study of two techniques used for tumor detection of MRI images. One is based on the Level set method that uses the non parametric deformable models with active contour to segment the brain tumor from the MRI brain images. The other one is the K-means segmentation algorithm. After the segmentation decision making is performed in two stages: Feature extraction using Discrete Wavelet Transform and Gray Level Co-occurrence Matrix, and classification using the Support Vector Machine. Dataset of MRI brain tumor images includes T2 weighted 17 benign and 24 malignant tumor images of different patients. SVM with Level Set and K-Means segmentation classify image into normal brain, benign or Malignant tumor with 94.12% and 82.35% accuracy respectively. Level Set method gives better results than kmeans segmentation.

K. Sudharani, Dr. T. C. Sarma, Dr. K. Satay Rasad [6] Proposed Methodology include methods like Histogram, Re-sampling, K-NN Algorithm, Distance Matrix. First, Histogram gives the total number of specified value of pixels distributed in a particular image. Re-sampling re-size image to 629X 839 for proper geometrical representation. Classification and identification of brain tumor by using k-NN which is based on training of k. In this work Manhattan metric has applied and calculated the distance of the classifier. The algorithm has been implemented using the Lab View. Algorithm has been tested on 48 images. The identification score for all images are about 95%.

Ketan Machhale, Hari Babu Nandpuru2 , Vivek Kapur3, Laxmi Kosta [13] proposes an intellectual classification system to recognize normal and abnormal MRI brain images. Under these techniques, image preprocessing, image feature extraction and subsequent classification of brain cancer is successfully performed. In pre-processing MRI brain RGB images are converted in grey scale image. Median Filter is applied to remove noise from mri image. Then Skull

Masking is use to remove non-brain tissue from MRT brain image. Dilation and erosion are two elementary morphological operations used for skull masking.

III. EXISTING METHOD

In a neural network you perform a series of linear combinations mixed with (usually) nonlinear activation functions across several layers.Neural networks are a powerful machine learning technique.

But, they have some limitations that you need to be aware.If you're working with small datasets, neural networks may not be the best choice. And, if you need to generate model results that are easy to explain, neural networks may also not be the best choice.In recent years, through research on artificial neural networks, it has been found that neural networks have powerful pattern classification and recognition capabilities. Therefore, ANN has been accepted by many different fields and used to solve complex problems (D. C., 2010) (Graves, A., 2009) (Graves, A., 2008).

Artificial neural network has many advantages that make it gradually accepted by more and more fields. First of all, artificial neural networks can be trained to contain examples composed of many attributes. Secondly, The ANN learning method is robust to noise in the training data, which means that the training samples may contain errors, but these errors would not affect the final output. And artificial neural networks can withstand a long training time, which depends on factors such as the number of weights in the network, the number of training samples considered, and the settings of various learning algorithm parameters.

Finally, it is a nonlinear classifier. The perceptron is a typical structure in artificial neural networks. Its main feature is simple structure, a convergence algorithm for the problems it can solve, and it can be rigorously proved mathematically (Goodfellow, I., 2016) This kind of neural network with only one hidden layer is called a single-layer perceptron.The one with multiple hidden layers is called a multi-layer perceptron, which can have more complicated connection patterns between layers and signals propagation methods in the hidden layers.

Therefore, multi-layer neural network constitutes many neural network structures that are now widely used, such as convolutional neural networks, long and short-term memory neural networks, and cyclic neural networks (Goodfellow, I., 2016).Thus, perceptron played an important role in promoting neural network research.

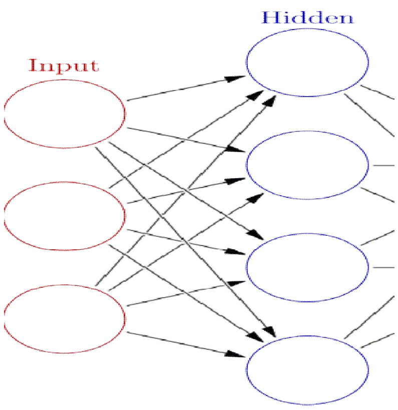

Fig 3.1: Composition of artificial neural network

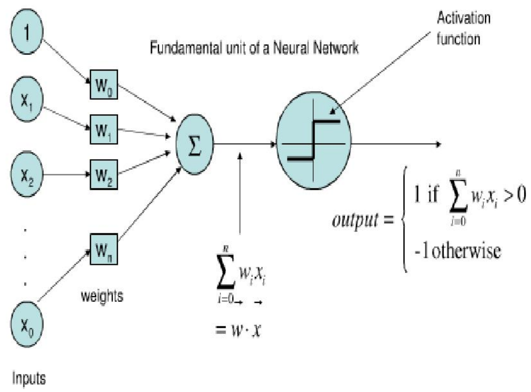

Fig 3.2: The graph of perceptron

IV. PROPOSED METHOD

1. SVM is a supervised machine learning algorithm which can be used for classification or regression problems. It uses a technique called the kernel trick to transform your data and then based on these transformations it finds an optimal boundary between the possible outputs.
2. In this proposed method we used PC (principal component analysis) for extracting features.
3. We generated a mail alert to patient includes the results of their uploaded MRI. This project aims to realize support vector machine to classify brain tumor MRI images and evaluate the performance of SVM classifier. By comparing the two classifiers, it is determined that a SVM is more suitable for the diagnosis of actual brain tumors. Simultaneously, it is also necessary to improve the performance of the SVM through reasonable parameter settings and network structure construction

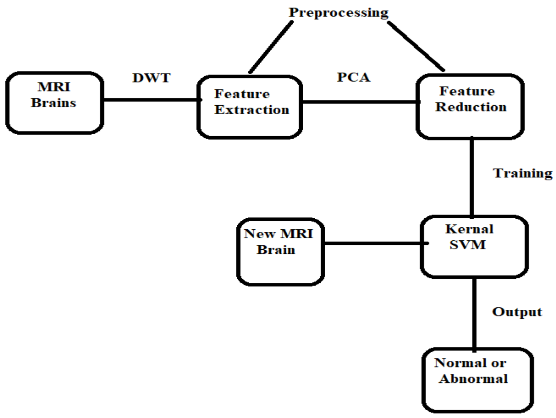

Fig 4.1: Algorithm for classification method

4.Support Vector Machine(SVM) is a supervised machine learning algorithm used for both classification and regression. Though we say regression problems as well its best suited for classification. The objective of SVM algorithm is to find a hyperplane in an N-dimensional space that distinctly classifies the data points. The dimension of the hyperplane depends upon the number of features. If the number of input features is two, then the hyperplane is just a line. If the number of input features is three, then the hyperplane becomes a 2-D plane. It becomes difficult to imagine when the number of features exceeds three.

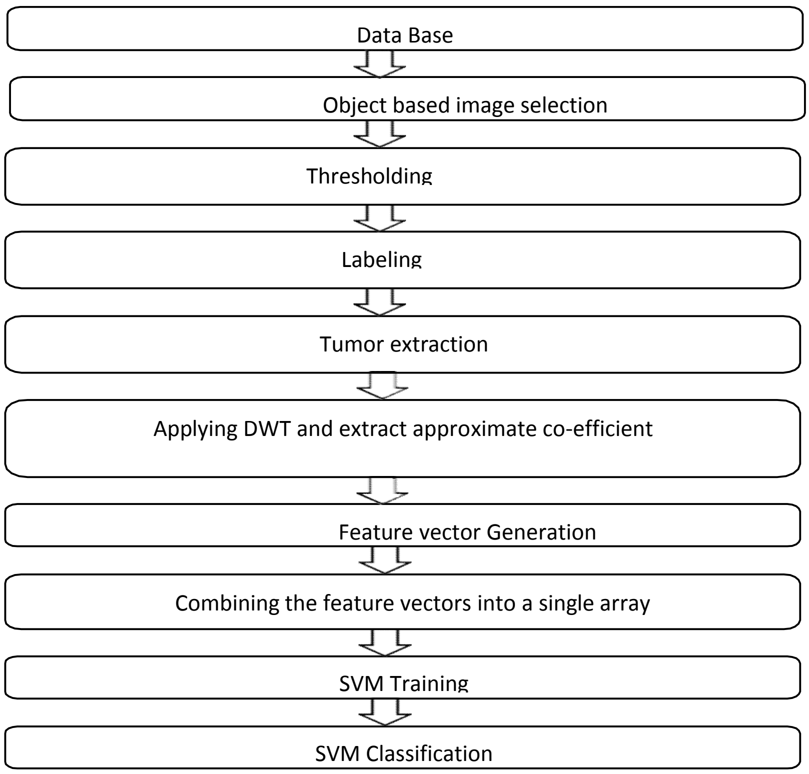

Fig. 4.2. The Complete flow of brain tumor classification

4.1 Database

The database is taken from www.cancerimagingarchive.com. The database is in DICOM (Digital Imaging and Communications in Medicine) format. The images are then converted to JPEG image format for the convenience using image converter software. The images can also be converted using Matlab.

4.2 Object Based Image Selection

The complete images are not feasible to classify, hence the object based i.e., the image, which consists tumor, are selected for further processing.

4.3 Thresholding

Thresholding is performed so as to additionally improve the determination of the delta outline gray scale. The individual pixels in the gray scale picture are set apart as question pixels if their esteem is more note worthy than some limit esteem (at first set as 80) and as foundation pixels generally. Thresholding speaks to the least complex picture division process and it is computationally reasonable and quick.

4.4 Tumor Extraction

Region description produces a numeric component vector or a non-numeric syntactic portrayal word, which portray properties of the depicted area. While numerous common senses hapeportrayal techniques exist there is no for the most part acknowledged system of shape depiction. The shape classes speak to the nonexclusive states of the articles having a place with similar classes. Shape classes ought to accentuate shape contrasts among classes, while the shape varieties inside classes ought not be reflected in the shape class depiction. The components of the picture are seen as appeared in Fig. 4.1. Recognition of pictured is tricts is a vital stride while intrans it to understanding picture information, requires a correct area depiction in a shape reasonable for a classifier. This description ought to create a numeric component vector, or anon-numeric vector depiction word, which describes properties of the region.

4.4 DWT (Discrete Wavelet Transform)

Wavelet transform is an effective instrument to represent an image. The wavelet transform permits multi-determination investigation of a picture. The point of the change is to extract relevant data from a picture. A wavelet transform partitions a signal into no. of sections, each comparing to an alternate recurrence band. Discrete wavelet change is helpful in picture handling since it can all the while restrict motions in time and scale.

4.5 Feature Vector Generation

Morphological tools are implemented in most advanced image analysis packages. Mathematical morphology is very often used in application where shape of objects and speed is an issue. For example analysis of microscopic images, industrial inspection, optical characters recognition and document analysis. And the feature vectors are combined into an array for further processing of data. The combinations of all the feature vectors are assigned into an array hence the data is processe done by one for the classification of the object.

For the extraction of features of each image, first image is converted to a binary image and then skeletonize the image. And then the image is divided to zones and then append zeroes hence a complete matrix of image is formed. The parameters that are used for the feature vectors are area Euler's number, height and width calculation, eccentricity and compactness.

The image is first pre-processed and then dwt is applied to the images hence absolute co-efficient are obtained. To that co-efficient the feature vector generation is performed using area, Euler number, height & width calculations, eccentricity and compactness parameters. Therefore 85 feature vectors are generated for an image. As I considered 27 images for tumor classification, 27 X 85 array has form to train svm. By combining these feature vectors 27X85 matrix is formed which is directly fed to the SVM.

4.6 SVM Training

Train an svm classifier with the svm train function. The most common syntax is SVM Struct = svm train (data, groups,' kernel_function', rbf); data: Matrix of data points, where each column is one feature groups: Column vector with each row corresponding to the value of the corresponding row in data. Groups should have only two types of entries. So groups can have logical entries or can be a double vector or cell array with two values.

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4.7 SVM Classification

Support vectors are the data points that lie closest to the decision surface. They are the most difficult to classify. They have direct bearing on the optimum location of the decision surface. We can show that the optimal hyper plane stems from the function class with the lowest capacity(VC dimension).

Support vector machines maximize the margin around these parating hyperplane, The decision function is fully specified by a subset of training samples, the support vectors, Quadratic programming problem.

4.8 Evaluation

The database was in DICOM (Digital Imaging and Communications in Medicine) format. The standard encourages interoperability of medicinal imaging gear by indicating and a restorative index structure to encourage access to the pictures and related information stored on trade media.

4.9 Train Set:

We use K-fold cross-validation for training the given dataset and obtain high classification accuracy only for the trained dataset. Cross validation methods consist of three types: Random sub sampling, K-fold cross validation, and leave-one-out validation. The K-fold cross validation is applied due to its properties as simple, easy, and using all data for training and validation. For this procedure, we create a K-fold partition of the total dataset where repeat K times to use K-1 folds for training and a rest of the fold for validation. After that we calculate the average error rates of K number of experiments.

The first row of each table is the basic images, which are converted to jpg format from DICOM format. In addition,thesecondrowindicatestheshapeextractedimagesofthecorresponding basic images. Finally, the third row shows the region extracted images respectively.

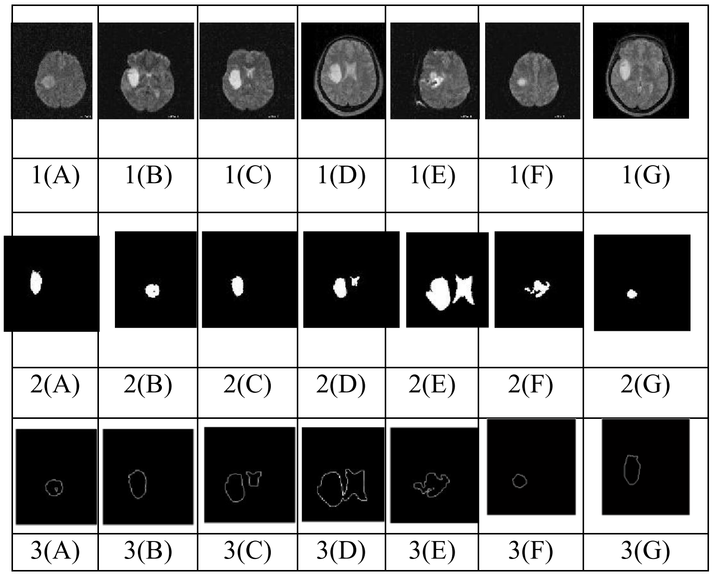

Fig 4.3: Extracted images MRI 1

V. RESULTS AND DISCUSSIONS

Finally, we apply our classification method with an appropriate experimental arrangement. Our experiment is divided by three steps/stages. Initially we create a well organized dataset, then design the process of simulation and finally simulate and observe the pattern of result. Here we briefly explain our process of experiment.

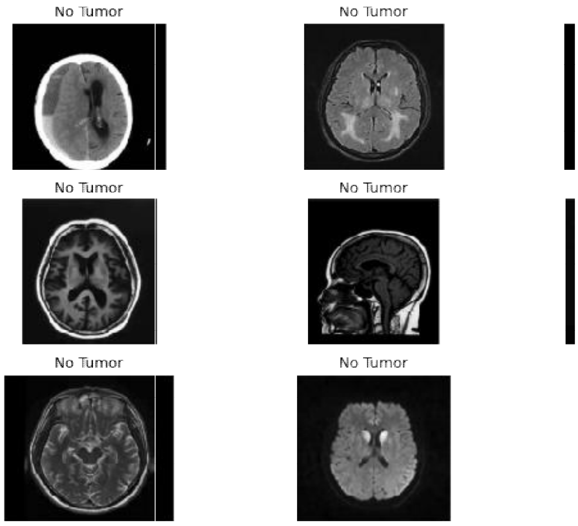

Fig 5.1: Results of no tumor dataset

we can see the results of no_tumor magnetic resonance imagining(MRI).By using SVM classification method, algorithms and segmentations to verify given MRI of brain is cancerous(Malignant) or non-cancerous(benign). In the segmentation procedure, the tumor part is segmented by the proposed strategy SVM means support vector machine. The segmentation procedure includes the original image, the classified tumor image, and the segmented image alongside the performance measures.

Fig 5.2: Results of positive tumor

We determine the two category of brain tumor from our training dataset of selected images which was extracted the values of significant thirteen parameters of brain MRI images. Finally, we categorize abnormal brain MRI as BENIGN and MALIGNANT.

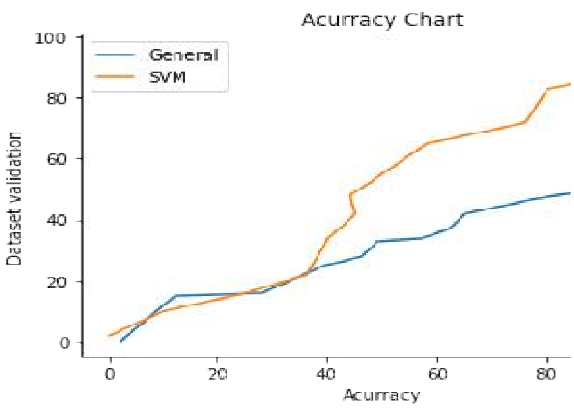

Fig 5.3: Accuracy plot for dataset

The result of the proposed model accuracy chart and the model's accurate during training and testing stages represents the accuracy value of SVM model (training and testing), the graph shows the effectiveness of the proposal model by achieved accuracy of 96.3%.In this accuracy plot orange line shows the accuracy of SVM classification.

VI. CONCLUSION

Experimental results showed that, our classification method can successfully separate normal and abnormal brain MRI images. Finally, cancerous and non-cancerous tumors are classified from abnormal brain MRI images. To categorize brain tumor, it can detect tumor and classify as benign or malignant. LPT provides accurate feature extraction and PCA reduces search space without misinterpreting detection factor. It is significant that our method can classify rotation and scale invariant image as well as T-1 and T-2 weighted neoplastic and degenerative brain diseases images. The accuracy measurement of our experiment gets perfection by using four kernels (RBF, LINEAR, POLYNOMIAL and QUADRATIC) operations. Almost in all cases, the proposed method gives better performance than that of the existing process. The combined performance of feature extraction and classification by using strong dataset make our method robust and efficient. This paper presents an prototype for object detection with SVMs that can achieve real-time performance while maintaining high detection accuracies. 96%of accuracy is obtained for testing and training are calculated. Furthermore, the same prototype can be used for different application regardless of the window size, number of support vectors, and image size.

VII. FUTURE SCOPE

In future work, on the one hand, when training the T1ce dataset, it can be found that the unstandardized dataset performs better than the standardized dataset. This finding does not fully explain that standardization should not be used to process the dataset when there are lots of features, but it is possible that other more reasonable data preprocessing methods should be used for the dataset to improve the performance of the classifier. Therefore, it is necessary to read more scholars' materials in the future to find a preprocessing method suitable for brain tumor MRI image classification. On the other hand, by evaluating the performance of the SVM, it is found that SVM has better classification performance in brain tumor classification. However, this conclusion is only reflected in the binary classification of MRI images of brain tumors for the time being. Therefore, in the future, it is necessary to study the performance of the classifiers in the multi-classification problem of brain tumors to extend this conclusion to a wider range of applications. In addition, in terms of the parameter adjustment of the classifier, the parameter adjustment of this experiment is manually adjusted according to the training result. In order to increase the efficiency and improve the performance of the classifier, you can try to use automated parameter optimization methods such as grid search. Grid search searches for parameters, that is, within the specified parameter range, adjust the parameters insequence according to the step length, use the adjusted parameters to train the learner.

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