

Early Detection of Brain Tumor in MRI Images - A Comparative Study

Thahseen P¹, Anish Kumar B²

¹MEA Engineering College, State Highway 39, Nellikunnu-Vengoor, Perinthalmanna, Malappuram, Kerala

²Assistant Professor, MEA Engineering College, State Highway 39, Nellikunnu-Vengoor, Perinthalmanna, Malappuram, Kerala

Abstract: Glioma is a common and malignant tumor, which may lead to short life span in their highest grade. Therefore to improve the quality of life of oncological patients is the early diagnosis of brain tumor, which is a major stage of treatment. MRI (Magnetic Resonance Imaging) is widely used medical imaging technique used to assess tumors, but large amount of data produced by MRI may vary greatly. Thus manual detection will be challenging. There exist many automated diagnostic systems which plays a major role in detection of brain tumors in MRI images. In this paper a comparative study of classification techniques namely Decision tree, SVM (Support Vector Machine), kNN (k - Nearest Neighbor), CNN (Convolutional Neural Networks) and DBN has been done. The system may mainly include three steps namely preprocessing, classification and post processing. In the above survey the performance of classifiers in diagnosing the brain tumor is compared using the parameters speed, accuracy and complexity.

Keywords: Glioma, Oncological, Support Vector Machine, k – Nearest neighbor, Decision Tree, Convolutional Neural Network, Deep Belief Network

1. Introduction

Brain tumor is a major type of cancer. Abnormal growth of cells in brain may lead to brain tumor. These tumors may be broadly classified into two namely malignant (cancerous) or benign (non-cancerous). Glioma is a common and malignant tumor, which may lead to short life span in their highest grade.

Gliomas can be broadly classified into LGG (Low Grade Gliomas) and HGG (Highest Grade Gliomas) where the former is less aggressive [1], [2]. After diagnosis the patients may not survive on an average of 14 months even under the treatment [3]. Therefore to improve the quality of life of oncological patients is the early diagnosis of brain tumor, which is a major step of treatment. Various techniques are existing to detect cancer but most of them are in advanced stage, own the chance of recovery of the patient. Due to overlapped structure of cancer cells the early detection of tumor detection is challenging. Surgery, chemotherapy, radiotherapy, or combination of them is the treatments used nowadays to cure brain tumor in their advanced stage.

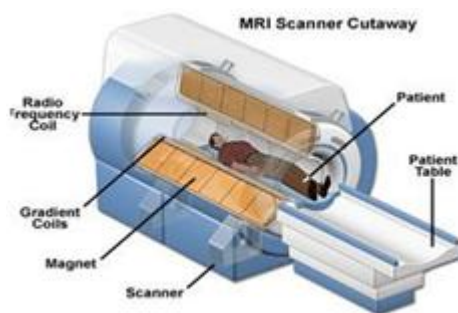


Figure 1:- MRI Scanning

MRI (Magnetic Resonance Imaging) is widely used medical imaging technique used to assess tumors, but large amount of data produced by MRI may vary greatly. Thus manual

detection will be challenging. Segmentation and classification of tumor in MRI images are done in order to find whether tumor affected or not and segment the area affected. The prescriptive methods used for the detection of brain tumor in their early stage are biopsy, manual inspection, expert opinion and etc. The biopsy method may take ten to fifteen days whereas human prediction will not be accurate always to give a result about tumor.

The major disadvantages of SVM are it is not easy to determine the optimal parameters when there is nonlinearly separable training data is present [7] and the method is likely



Figure 2: Tumor affected MR image

There also exist many automated diagnostic systems which plays a major role in detection of brain tumors in MR images. To segment and classify the features in MR images many classification techniques are used such as SVM (Support Vector Machine), KNN (K- Nearest Neighbor), NN (Neural Networks), DBN (Deep Belief Network) etc.

2. Preprocessing

Preprocessing of MR images is the primary step of brain tumor detection. Many preprocessing techniques exist which may include intensity normalization, filtering, histogram equalization etc. Preprocessing of images is done in order to reduce the noise and thereby enhances the MR images. The

main purpose of these methods is mainly to improve the quality of image thereby, improves image to get more surety and ease in detecting the tumor. In the proposed technique intensity normalization is applied on each sequence to make the contrast and intensity ranges more similar across patients and acquisitions. We compute the mean intensity value and standard deviation to normalize the MRI images across all training patches extracted for each sequences. On each sequence, we normalize the patches to have zero mean and unit variance.

3. Classification Methods

3.1. SVM (Support Vector Machine)

Sahoo, Laxmipriya, et al. [4] Support vector machine is an algorithm that constructs a hyper-plane to analyze data and classify objects. SVM is also be used for regression. Fig. 3. Show the SVM analysis.

SVMs are widely used in machine learning. They are also known as support vector networks. The associated algorithms analyze the data and recognize the patterns that are used for analysis. Classification and regression analysis. If a set of training examples were given, each example marked as belonging to one of two categories, an SVM training algorithm constructs a model that assigns new examples into one category or the other [5], making it a non-probabilistic binary linear classifier [4].

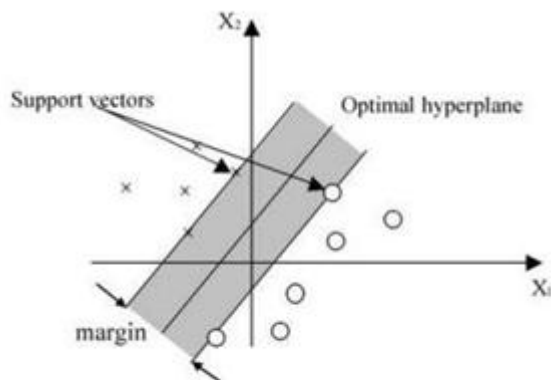


Figure 3: SVM analysis [4]

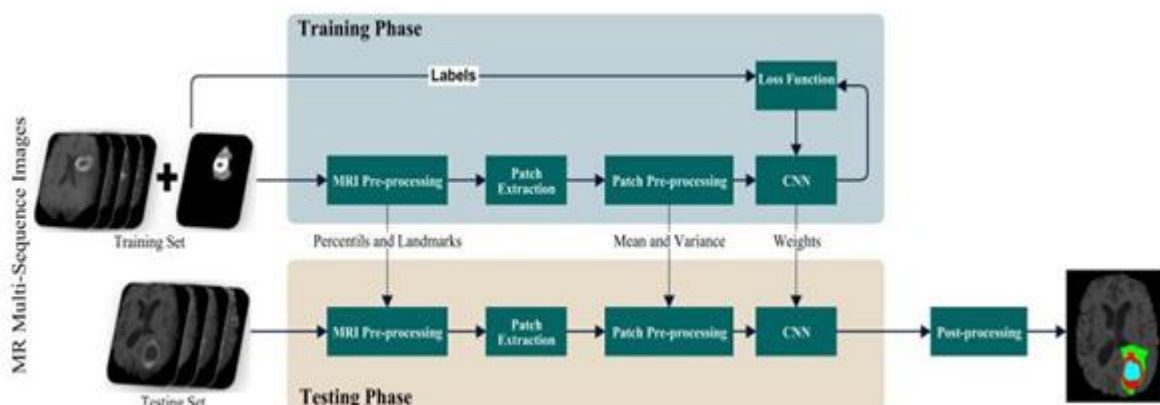


Figure 5:- Proposed Method (CNN)[8]

to give poor performance, if the number of features is much greater than the number of samples [6].

3.2. k-NN (k- Nearest Neighbor):-

Arriaga-Gómez and Miguel F et al [9] k-NN is one of the major distance-based algorithms; where given k as a positive integer and a sample feature vector (sample template), the k training features with the smallest distance to the sample is selected. The sample is identified as the most repeated among the selected k feature vector.

Ramteke R. J. and Y. Khachane Monali et al [10] proposed automatic classification method of medical images into Normal and Abnormal based on automatic abnormality detection and image features.

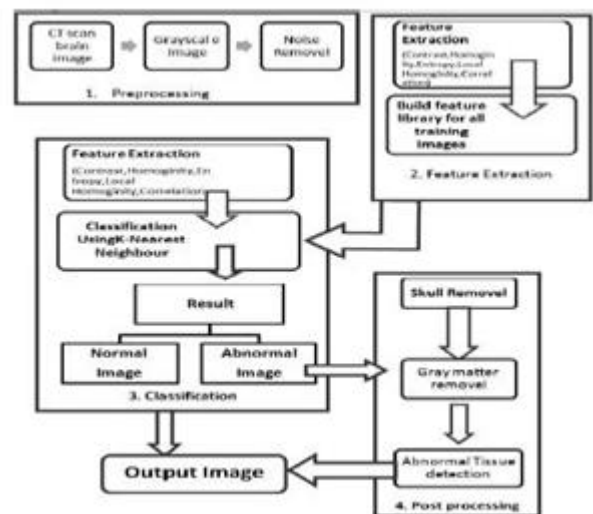


Figure 4:- The proposed work (k-NN) [10]

The major advantages of k-NN are simpler to implement and understand. The result will not be accurate always as it determines its class assignment by either getting a majority vote for them or averaging the class numbers of nearest k points.

3.3. CNN (Convolutional Neural Network)

S. Pereira, A. Pinto, V. Alves and C. A. Silva et. al [8] says among the variables that consist the input layer (or visible that to achieve some breakthrough results and win well-layer) or all hidden layers [13]. Since DBN is a deep learning known contests CNN were used. Convolving an image or a method its accuracy rate is more when compared to other signal with kernels to obtain feature maps is the main classifiers. Application of CNN In paper [8] single layered CNN is used so the features used for classification is less when compared to deep networks

3.4. DT (Decision Tree)

Decision tree is a tree-like graph of decisions. Each branch represents the decisions to make graphically. It is a nonparametric, supervised approach. DT calculates the class membership by repeatedly dividing one data set uniform sub-sets. Hierarchical classification permits acceptances and the rejection of class labels in each intermediate stage. This method consist of 3 parts: partition of nodes, look for the terminals and class assignment label the terminal nodes. DT is easy to interpret and explain but its classification error rate is high.

3.5. DBN (Deep Belief Network)

Das, Deepjoy, and Alok Chakrabarty et al [13] proposed an automated classification method which mainly focuses on recognition of facial emotion using a dataset comprises of four kinds of emotions (happy, angry, neutral And sad) with different models of deep neural networks and compare its performance.

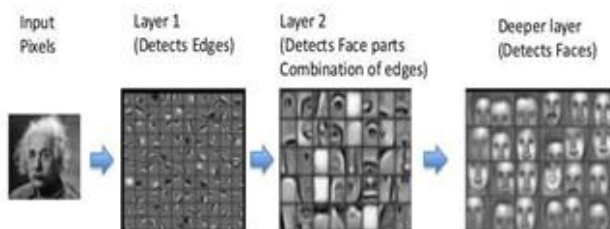


Figure 6:- Face recognition using DBN [13]

A DBN is a generative model (which can be completely unsupervised) that mixes directed and undirected interactions

4. Results and Discussions

Advantages and disadvantages of 5 classification methods such as SVM, CNN, DT, k- NN and DBN are mentioned in the below table 1.

Table 1: Advantages and disadvantages of classification methods

Methods	Advantage	Disadvantage
SVM	• Deliver unique solution	Not easy to determine the optimal parameters when there is non linearity separable training data
	• Avoid over fitting	
k-NN	• Are simpler to implement and understand	The result will not be accurate always

DT	• Easy to interpret and explain	Classification error rate is high
DBN	• More features are used to implement	takes more time
CNN	• robust to noisy training dataset	high computational cost

DT and k-NN are easy to implement but error rate will be high. Since CNN used in paper [8] is single layered CNN, only a single feature is used to detect the brain tumor in MRI images. In DBN more hidden layers are present, so more than 1 feature is used to detect brain tumor in single layer itself. Hence we can conclude that DBN is more accurate than single layered CNN.

Comparison parameters for classification in detecting brain tumor in MRI images are:-

- Speed
- Complexity
- Accuracy

Table 2: Performance comparison Table of Classification Methods

Methods	Speed	Complexity	Accuracy
SVM	Less	High	Less
k-NN	High	Less	Moderate
DT	High	Less	Moderate
DBN	High	Less	High
CNN	Moderate	High	Moderate

5. Conclusion

This survey attempts to study different image classification methods. By comparing various classifiers it can be concluded that each classification methods have its own advantages and disadvantages. DBN is better when compared to others in case of accuracy but it will take much time whereas SVM, DT and k-NN are simple to implement but will not accurate always. Hence we can conclude the survey that accuracy of the result is much important so deep neural network is preferred more

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Author Profile



Thahseen P. received her B.Tech. degree in computer science and engineering from the MEA Engineering College, Kerala, in 2015. Right now she is pursuing her M. Tech degree in computer science at MEA Engineering College, Kerala from 2015 to 2017. Her research interests lie in Image Processing.



Anish Kumar B received his B.Tech. degree in computer science and engineering from the college of Engineering, Karunagappally, Kerala, in 2006. He had completed his M. Tech degree in computer science at college of Engineering, Chengannur, Kerala from 2014. His research interests lie in Image Processing