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Classification and characterization of brain tumor MRI by using gray scaled segmentation and DNN

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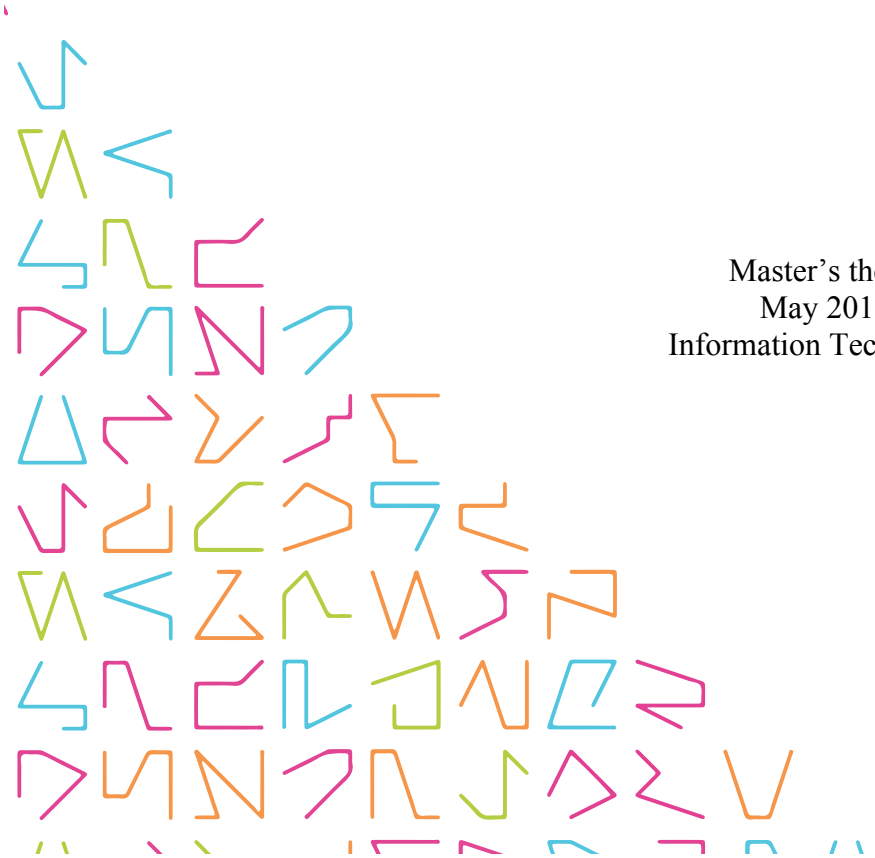

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ABSTRACT

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Many efforts have been made for image segmentation and classification. Different techniques have been adopted for this purpose. Image segmentation is very valuable especially in biomedical field for diagnosing disease. Magnetic resonance imaging (MRI) is playing very important role in the research of neuroscience for studying brain images. This study of brain MR Images is helpful in brain tumor diagnosis process. Features will be extracted (on the bases of tumor region, texture, color, location and edge) and selected from the segmented images and then classified by using the classification techniques to diagnose whether the patient is normal (having no tumor) or abnormal (having tumor).Implementation of combination of techniques will increase the accuracy of results. In this thesis an effort will make to list and cover previous work of different researchers to improve the accuracy of diagnosis process.

Key words: DNN classification, gray scaled segmentation, tumor detection.

CONTENTS

GLOSSARY or ABBREVIATIONS AND TERMS (choose one or other)

FLAIR	Fluid Attenuated Inversion Recovery
CSF	Cerebrospinal fluid
LS-SVM	Least Squares Support Vector Machines
PCA	Principal of component Analysis
LDA	Linear Discriminant analysis
SURF	Speeded Up Robust Features
SIFT	Scale Invariant Feature Transform
SOM	Self-organizing Map
DNN	Deep neural network
CT	Computed Tomography
PET	positron emission tomography
TE	Time of Echo
TR	Repetition Time
WM	White Metter
GM	Grey Metter
ISODATA	Iterative Self Organizing Data Analysis Technique Algorithm
TP	True Positive
TN	True Negative
FP	False Positive
FN	False Negative
LTP	Local Ternary Pattern
RBF	Radiant Basis Function
FCM	Fuzzy C mean
ANFIS	AN Fuzzy Inference System
PNN	Probabilistic Neural Network
DWT	Discrete Wavelet Transform

INTRODUCTION

Introduction

This study of brain MR Images is helpful in brain tumor diagnosis process. Tumor and cancer is a harmful and death-defying disease for human life. This study is another effort to reveal the importance of the image classification in the world of the Biocomputing field. Image classification technique is efficiently improving the process of disease diagnosis. It is a process in which images are labeled into numerous predefined classes. Several techniques has been introduced for image classification like SVM, Boltzmann, fuzzy C-mean, random forest and many others. This study proposed a model in which deep neural network technique is used with grey scaled segmentation technique. Combination of these two techniques is giving better result in minimum computational time.

Problem statement and objective

The aim of this study is to propose a model which evaluates the impact of deep neural network on the grey scaled segmented images. This combination provides the better results and helps in diagnosis of disease more efficiently and in minimum time span.

Contribution

This study is contributing in the field of image processing by introducing a model which can diagnose tumor more accurately and efficiently. Along this model, this study involved other tasks given below.

- A review of classification technique and discuss the combination of it with other techniques.
- Proposing model of DNN with grey scaled segmentation technique.
- Improving a diagnosis process of brain tumor for the effective and timely treatment.

Scope and Significance

In this study, a review of the previous work of last ten years is discussed for comparison purpose. DNN technique is used for classification on the grey scaled segmented MR Images to get accurate result for treatment planning and improvement.

This study provides help to radiologist, doctors and surgeons in diagnoses of disease in very short time and with the high accuracy. This study will contribute effectively in the field of image processing.

Thesis structure

The study is evaluating in the form of different chapters. Thesis structure is given below according to chapters. Chapter no.1 Introduction tells about research topic, its aims and objective and importance of this whole study. Chapter no.2 concepts and terminologies help for the nave users to understand the important and basic concept relevant to the

study. Chapter no.3 research methodology illustrates the methods and plan of the study to make it successful.

Chapter no.4 literature review is a detail explanation of previous work of researchers about relevant study.it also illustrates the best technique from the previous work by comparing the accuracy results. Chapter no. 5 results and discussions articulate the implementation and their results which are taken from experiment. Discuss the analysis of researcher of this study with the help of final results. Chapter no 6 is for conclusion of the whole study and future recommendations.

Summary

In this chapter of introduction describe the research topic, aim and objective of this study, problem statement, importance and scope of this study. Last section of this chapter describes structure of whole thesis.

Concepts and Terminologies

This chapter will help to understand the basic terms and concepts of the relevant topic which are necessary to clarify the problem and solution. Brain tumor and its detection, image processing and analysis and many other background facts and material is important for native researchers

What is tumor?

Tumor [1] is an anomalous mass which may exist inside or on the brain. Two different terms are used for this anomalous and abnormal part in the brain.

- Tumor
- Cancer

Tumor and cancer does not have the same characteristics. **Tumor** is a solid or fluid filled mass of abnormal tissues. Tumor is also called neoplasm. Tumor can be categorized into primary and secondary tumor [2]. Primary tumor is composed of cells of that organ where tumor locates. Mostly primary tumor is supported by nervous system to grow up, and tumor's growth is very slow. This type of tumor which is related to nervous system is called gliomas and glias cells of brain are the building-block.

Cancer is a rapid and uncontrollable growth of abnormal tissues which damages the nearby health tissues of brain.

Tumor is categorized into Benign [3], Malignant [4] and pre-Malignant [5].

Benign → contains has non-cancerous characteristic.

Malignant → contains cancerous characteristic.

Pre- malignant→ has pre-cancerous characteristic.

Secondary tumor is composed of cells which belong to the different and others parts of the body. It can be spread quickly. In other words, it can be said that cancer cells are the cause of secondary tumor. So, it is concluded that all tumor are not cancer but all cancers are tumor. Tumor can be classified on the basis of different criteria as give below:

- Tumor localization in skull
- Tumor localization in brain
- Localization in compartment

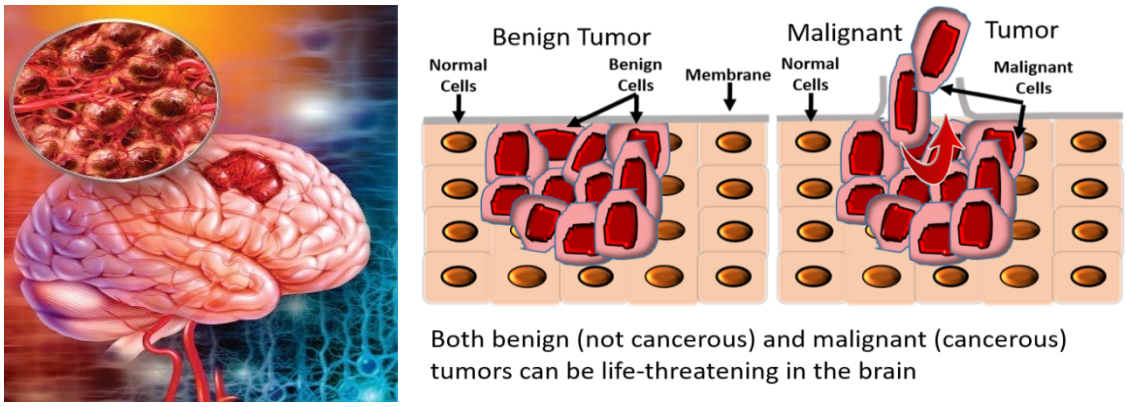
Other than this, tumor is also categorized on the basis of cells which compose the tumor like

- Tumor composed of neuron cells
- Tumor composed of glila cells
- Tumor composed of germs cell
- Tumor composed of meninges

Dominant pathology base categorization is given below

- Benign
- Malignant

Different brain images which are affected by tumor at different location.



(a) (b)

FIGURE2.1. Example of brain image a and b with tumor

Medical imaging and Diagnostic techniques of brain tumor

Timely diagnosis helps in treatment procedure. Different techniques are used for the diagnosis tumor and cause and effects of that disease like brain biopsy and brain imaging system

Biopsy of brain is a procedure in which a hole is grilled in the skull and piece of tissue and tumor is removed to examine the tumor, type of tumor, its composition and cause of tumor under the microscope. FIGURE 2.2 shows the biopsy process [7].

This technique is very risky for human life. Imaging technique is also used in biopsy to locate the tumor and get the part of tissue.

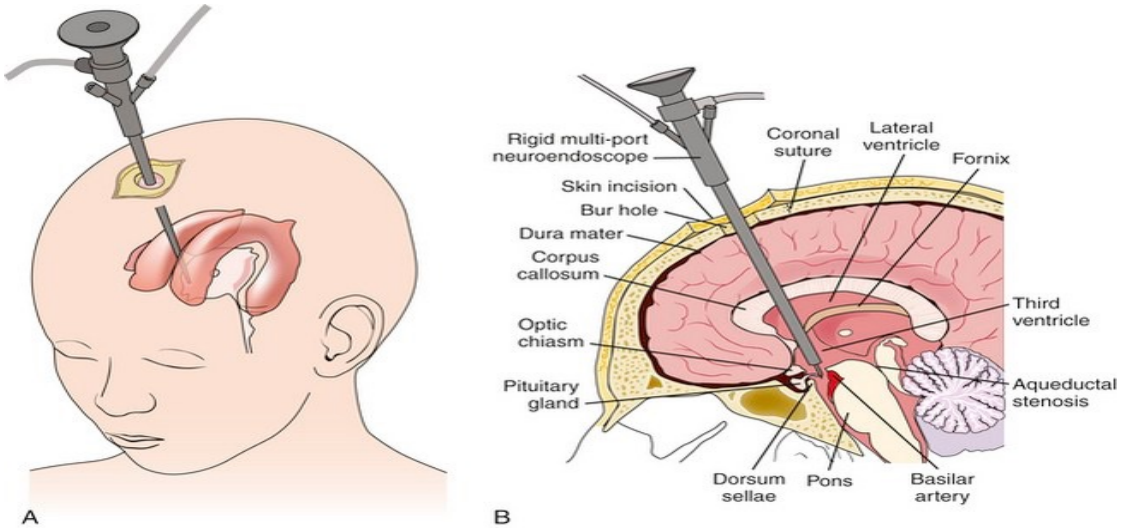


FIGURE 2.2 Biopsy of brain

Different imaging techniques are used to get the images of brain so that tumor can be diagnosed with its location and size of tumor like x-rays, CT scan and MRI [8].

CT scan [48] is an important imaging technique in the field of medical and provide information in seconds and usually the duration minimizes to the fraction of it. It helps in providing more clear information than X-rays but the risk of radiation exposure is very low

PET is a positron emission tomography in which a radioactive material is injected in the blood and a scanner detects this material to get the image. This technique gives an idea of brain's activity and function. This method is cost effective harmful material is used.

X-rays is an imaging technique which does not give the detailed information about the organ. X-rays may cause skin cancer if it used multiple times on the same body and place. But this technique is less expensive and easy to use.

MRI is another technique which uses the radio frequency signals to get the image of brain. This imaging technique is our focusing technique.

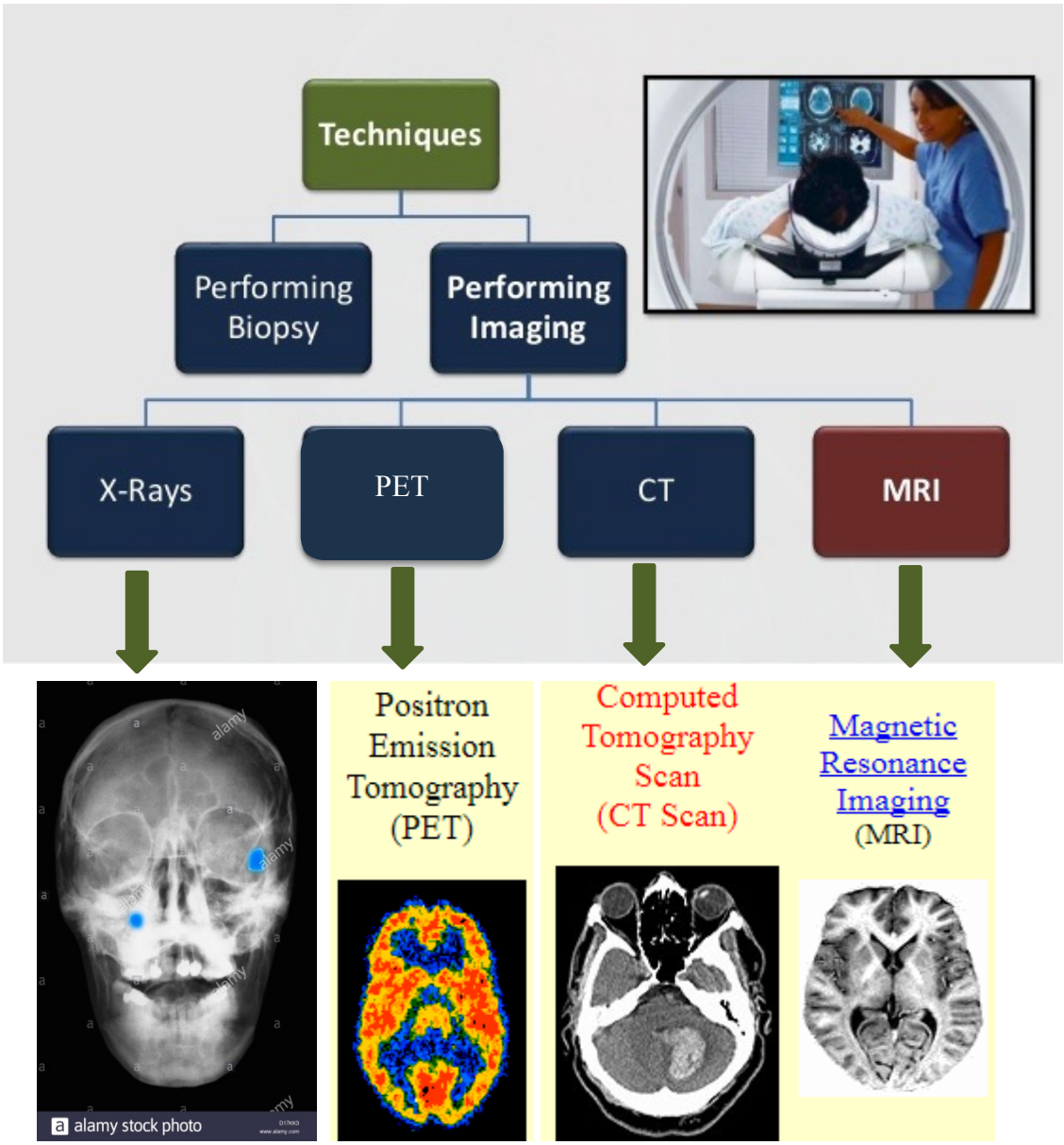


FIGURE 2.3 Different technique of Brain tumor imaging.

MR Image characteristics of brain tumor

MRI is an imaging technique [9] which is more useful than then X-ray. MR images do not used harmful radiations and provide the enough information for disease diagnosis and decision making for the doctors. MR Images are used in pre-processing of brain tumor detection and diagnosis [10]. Different types of MRI are used in this procedure according to the requirement. Type of sequences used in MRI provided as an input in the preprocessing step like T1, T2 and FLAIR.

To understand the concept of different types of MRI images, it is necessary to clear the concept of the TE and TR. TE is the (time of echo) time difference between the delivery of RF pulse and the receiving of echo signal. TR is (repetition time) the reception time between two continuous pulses applied in a same sequence.

T1-weighted images [11]: contain dark appearance of CSF and fluid. Gray matter (GM) is darker than white matter (WM). T1 gives better result in the case of brain structure images and fat appears brighter in this type. TE and TR time (TR→500msec, TE→14msec) is short to produce the images (uses longitudinal relaxation).

T2-weighted images [12]: which contain higher signal intensity of CSF and fluid as compare to tissue and for that reason it appear bright. T2 used long time (TR→4000msec, TE→19msec) for TE and TR to produce images (traverse relaxation). T2 is brighter for water and fluid, ideal for the oedema tissue

FLAIR [13] is just like to T2 but it has attenuated CSF fluid but abnormalities remain bright. It is good for imaging the cerebral oedema. It uses very long TE and TR time (TR→9000msec, TE→114msec) for producing images. FIGURE 2 represents the difference between these types of sequence in MRI image.

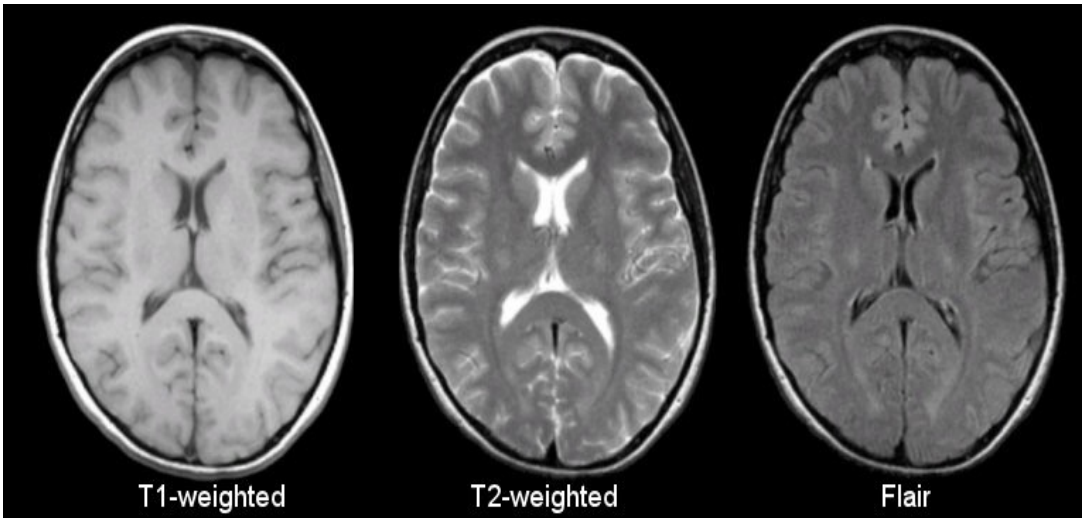


FIGURE 2.4 Type of MRI imaging technique

With the additional features of T1, T2 and FLAIR are illustrated with the help of table 2.1 given below.

Table 2.1 Represent the differences on the basis of different types of issues

Tissues	T1-weighted	T2-weighted	FLAIR
CSF	Dark	Bright	Dark
White matter	Light	Dark grey	Dark grey
cortex	Grey	Light grey	Light grey
Fat(within bone marrow)	Bright	Light	Light
Inflammation (impurity)	Dark	Bright	Bright

Marks of Brain structure

Three-dimensional biological structure of the brain is used so that any point inside or on brain can be localized on three "axes" or "planes" - the x, y and z axes or planes. The brain is often imaged on two-dimensional images (slices). These slices are usually made in one of three orthogonal planes: coronal, horizontal (axial) and sagittal as shown in FIGURE.

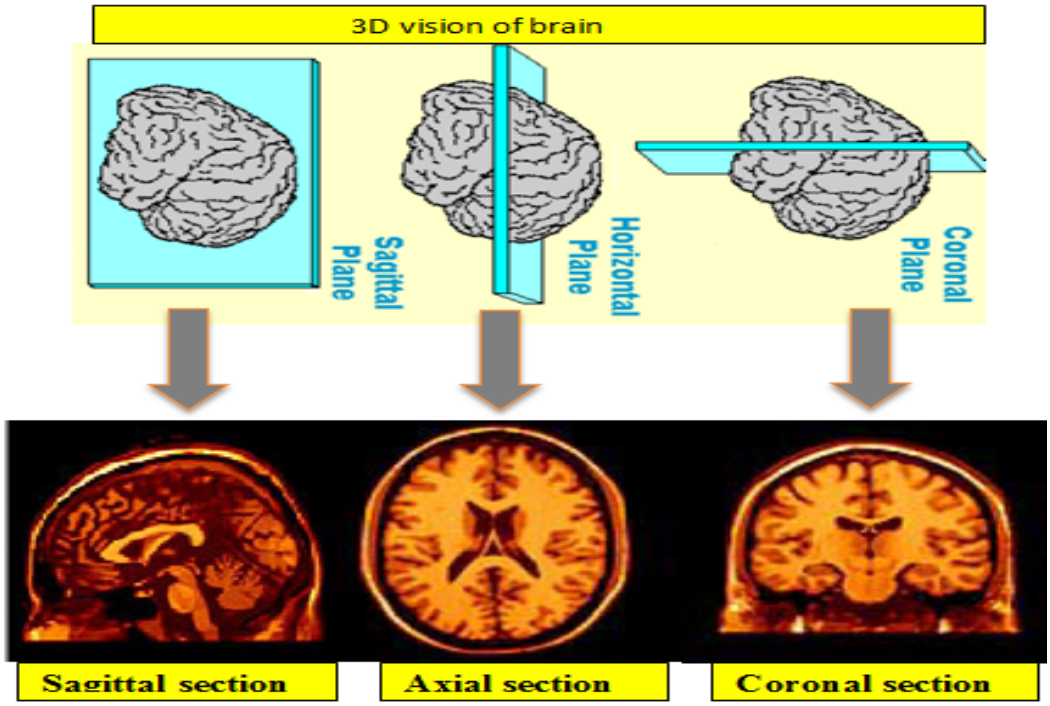


FIGURE 2.5 3D and 2D vision Brain

Image processing and analysis methods

Different Image processing methods and techniques are used to make the image more clear and enhanced so that accurate diagnosis can be performed. Different ways are adopted for this purpose but the targeted area of this study is limited to the major steps like filtration, image segmentation, features extraction selection and classification. These major techniques will lead to accurate diagnosis of tumor from brain MR images.

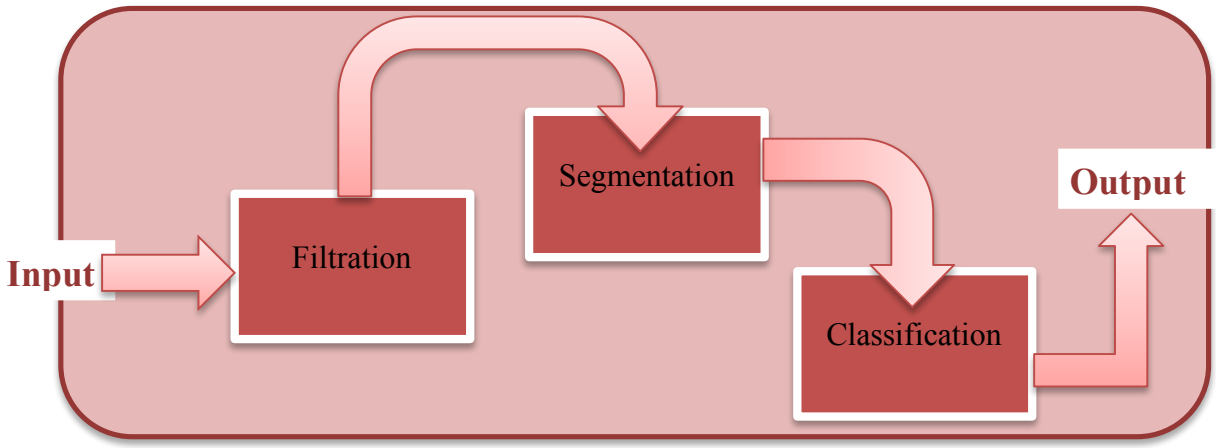


Figure 2.6 Image processing and analysis method

Image filtration and de-noising

Image filtration and de-noising is the first preprocessing step dealing with image processing. In image, de-noising is processed using certain restoration techniques to remove induced noise which may creep in the image during acquisition, transmission or compression process. This process increases and enhances the quality of image to get the better and accurate results.

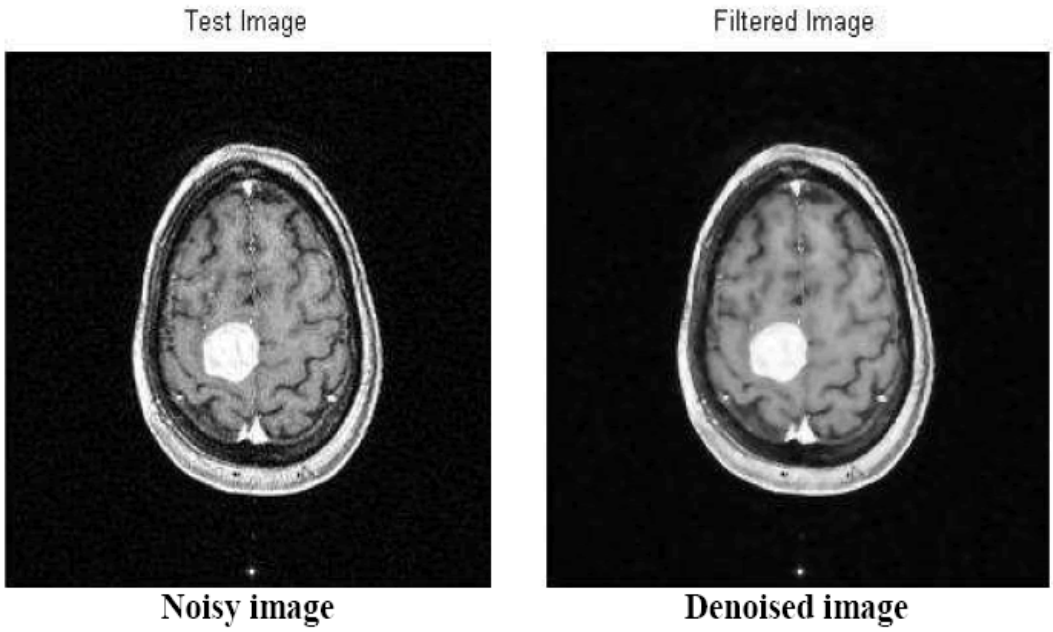


FIGURE 2.7 Example of noisy image and de-noisy image

Image segmentation

Image segmentation is a technique which divides the images into parts on the basis of dissimilarities and every part (pixel) contain similar features. Segmentation of the image [14] has different types as mentioned in FIGURE 2.7.

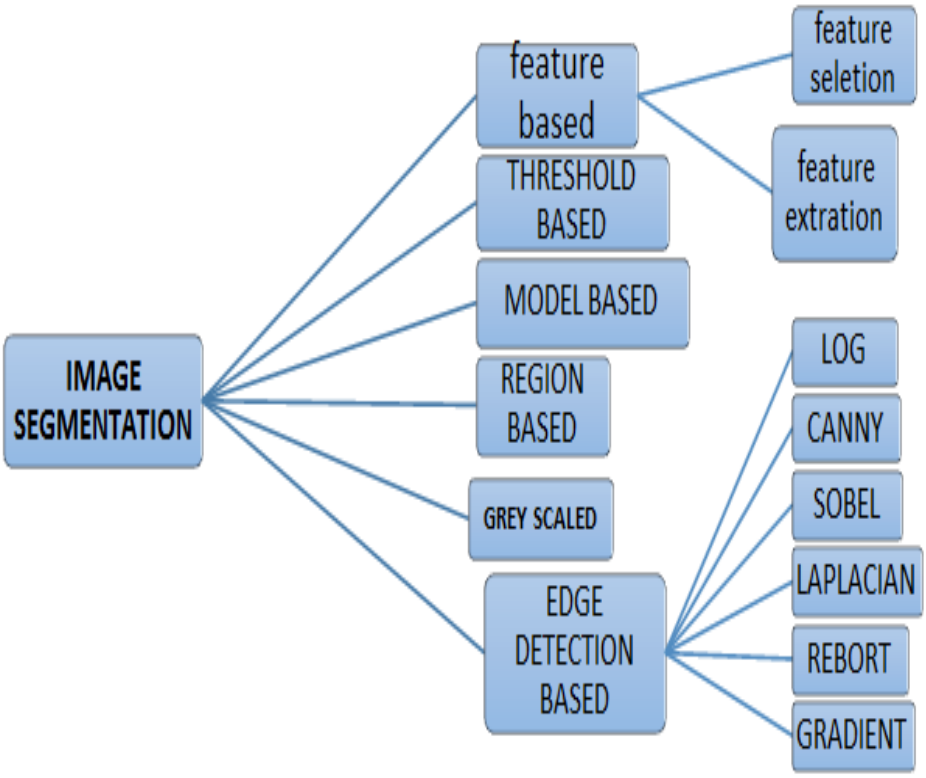


FIGURE 2.8 Types of image segmentation

Image classification

Image classification is a process of extracting the classes of information from the multi-band raster images. Basically, three types of classification: pixel-wised, sub pixel-wised and object-based. Main focus of this study is pixel-wised image classification [15] which can further be separated by three groups: supervised classification (user guide-line), unsupervised classification [15] (calculated by software) both are most common approaches but object based image analysis is very uncommon and latest technique as mentioned than remaining two and in this technique, high resolution images are used as an input. FIGURE 2.8 represent the different type of image classification on different point of view.

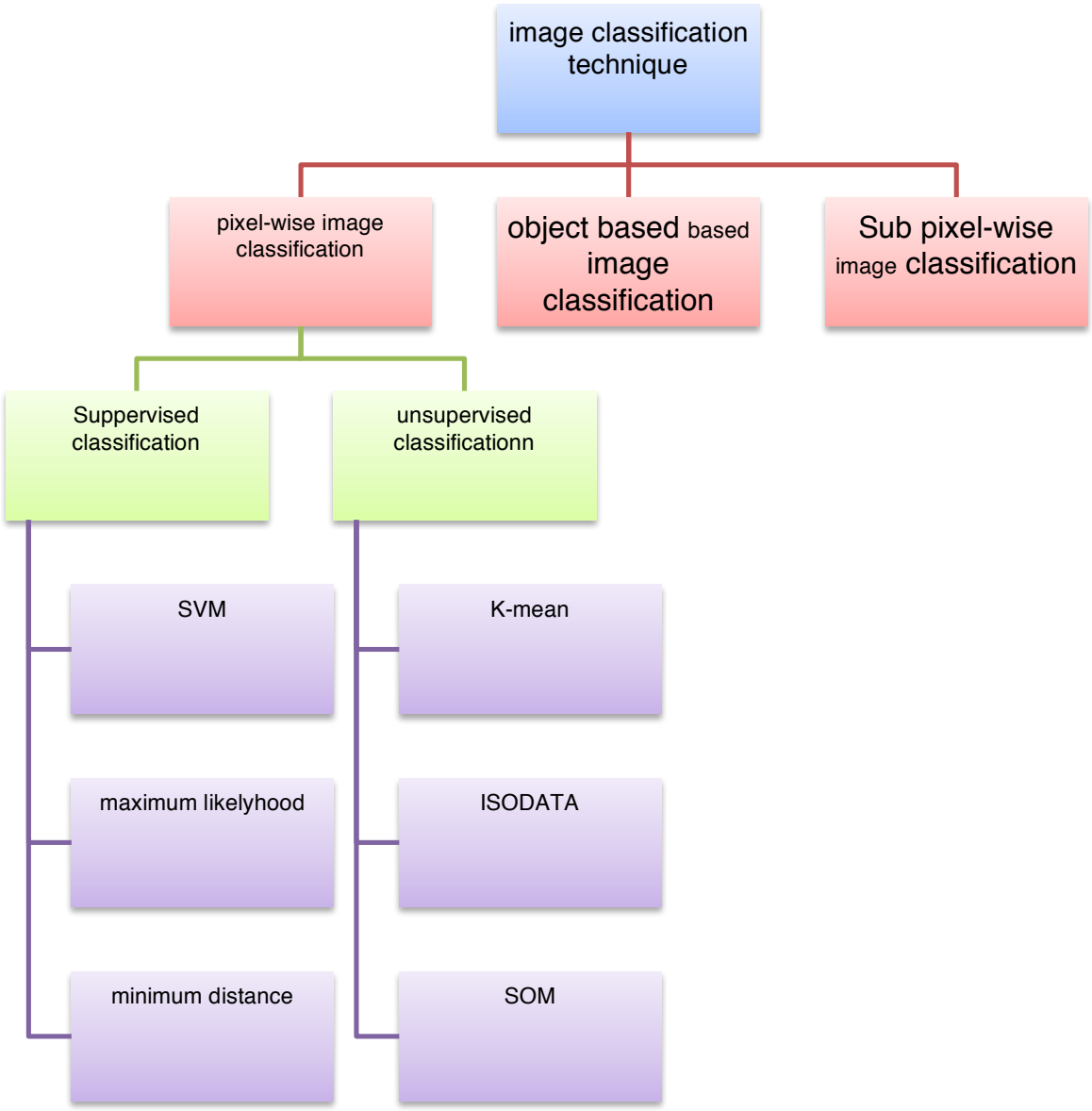


FIGURE 2.9 Different types of image classification techniques

Unsupervised classification is very simple technique because there is no need of samples in it. Simple steps of segmentation and then classification is performed to analyze the image. Examples of unsupervised technique are K-mean, ISODATA, SOM and many others.

Supervised classification technique is also which need sample in form of training sets. It performs three steps of selecting training area, generating file (specification of each class which resembles most in training set) and then classify image. The most common supervised techniques are maximum likelihood and minimum-distance classification. SVM is also very known and famous technique for image classification technique. It is observed that SVM is best as a supervised classification. But SVM can also behave as an unsupervised technique in some situations

Summary

In this chapter, all concepts and terminologies are discussed which are necessary to know to understand the problem statement and its solution. This chapter reveals the following

- Tumor and it types
- Imaging techniques
- Brain marks and structure
- Image filtration and de-nosing
- Image segmentation.
- Image classification

Research Methodology

As it is indicated in the title, this chapter includes the research methodology of the study. Further details of this section provide the outlines of the research strategy, the research method, the research approach, the source of datasets, the research process, type of data analysis, the ethical considerations and the research limitations of the study.

Research strategy

The given flow diagram will demonstrate the plan and actions to achieve the objective of study and to reach at its conclusion point

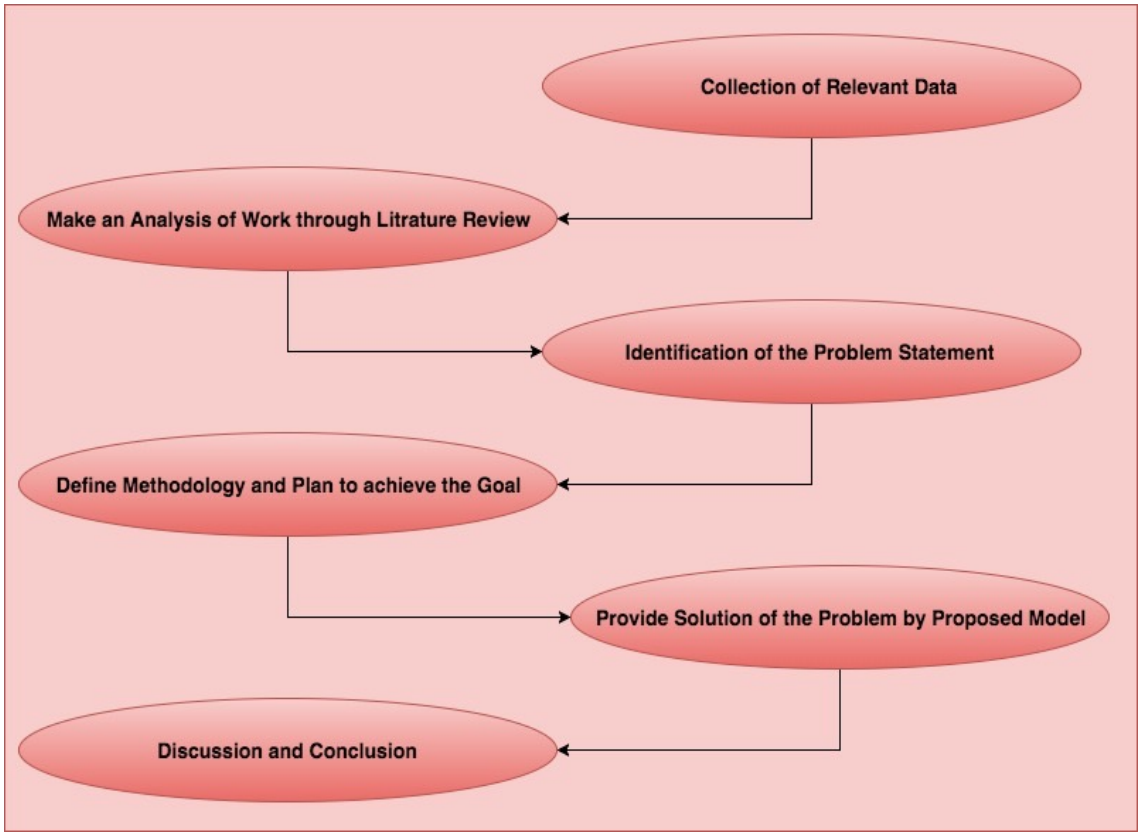


FIGURE 3.1 Representation of research plan and actions

Collection of relevant data and analysis

This study is following both descriptive and experimental analysis. Related data will be collected through books, magazine, research papers, articles, thesis and internet. All collected study material will be arranged for analysis. Discuss the topic and material with teacher for guide and to reach at some final point.

Literature review

Collected and arranged material will help to get knowledge about the previous work. This critical analysis will help in describing the positive and negative points of previous study which will help to identify the problem statement.

Identification of the problem

The analysis and discussion will lead to the identification of problem statement.

Proposed model to solve the problem

Next step will be to find the solution of the identified problem statement. This proposed work will give the better and efficient results.

Implementation of the proposed model

Implementation the proposed model and algorithm by the matlab toolbox and get the results.

Discussion and conclusion

This step will lead the final brief discussion of the whole study and describe the recommendations of it. Discuss the efficiency and betterment of the proposed work Future work will also be mentioned for next researchers.

Research methods

This study will be literature based. Its means that methodology of theoretically analysis which includes selection and discussion of theoretical material and descriptive material in the context of detailed comparison of theories, finding issues and try to resolve by the proposing solution model. The study will be empirically focused.

Datasets

Internet will be a source of relevant data (research papers, thesis and books). collected data of brain tumor classification technique of the previous researchers, on which comparison will be applied on the basis of different attribute like

- Technique (which is used for image processing)
- Accuracy rate

Dataset of MR Images will obtain by internet (webBrain website). Different type of MR Images will be available according to requirement.

Data analysis technique

Collected data will be analyzed and compared on the basis of different attributes. Specific technique or algorithm which is used to examined the brain MR images. The technique which will be used for the classification of MR image in the proposed model is Deep Neural Network [16]."Normal" neural networks usually have one to two hidden layers which are considerably used for the supervised prediction or classification. Deep learning of NN (neural network) architectures is different from "normal" neural networks because of having additional hidden layers as shown n FIGURE3.2.

Deep neural network is a computational model having the nature of human brain. According to human brain the DNN [49] is also interconnect processing elements (neu-

rons). These elements define the task of network. And processing is divided into groups called layers. DNN contains three layers which are input layer, output layer and hidden layer. When images are process by DNN and give input in the form of image leads toward the output in the form of vector of scores, one for each object class. The class with the highest score indicates the most likely class of object in the image. The goal for training the DNN is to regulate the weights which maximize the scores of the correct class and minimize the scores of the incorrect class. During training of network, correct class is considered the gap between the computed scores and corrected scores is called lose, the goal of hidden layer is to minimize the average lose over the large training set.

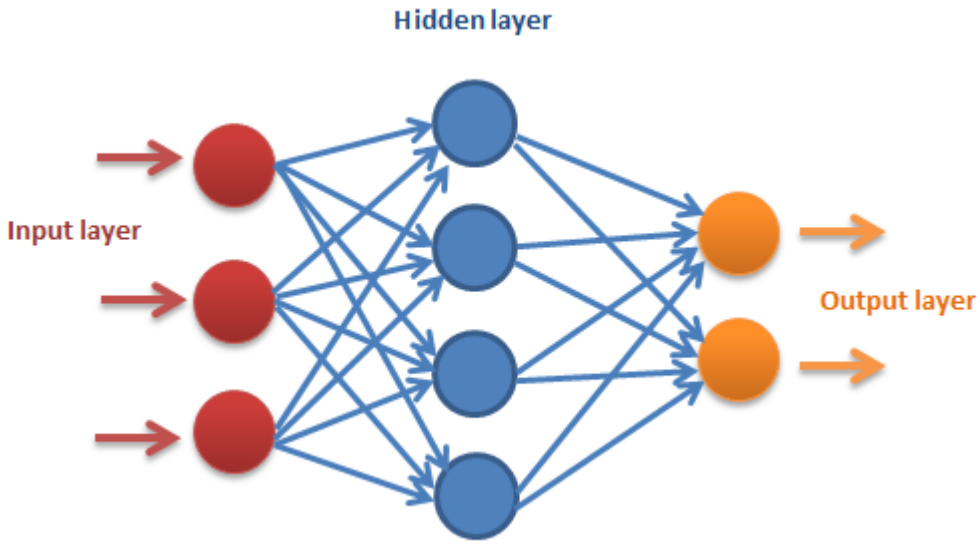


FIGURE 3.2 Structure of DNN in layers

Deep learning is not only differing from "normal" NN but support vector machine (which is the most popular and common algorithm for classification) because they can be trained in an unsupervised or supervised manner for both unsupervised and supervised learning tasks. Before the classification, images will be filtered to enhance the quality of MR image. This filtration will assist to de-noise and improve the quality of the MR images. Grey scaled segmentation [17] will be used for further processing of filtered images and make it ready for classification and to get the better results. Classified results will help to compute the Area of detected tumor in the brain tumor MR Images. For this purpose, area calculation of image algorithm will be used. The classified image will be divided into pixels and calculate the rows and columns according to algorithm.

Software (analysis tool)

Matlab [18] is a tool for the analysis. Matlab tool (matlab_R2017b_win64) from mathswork will be used to check and analyze the efficiency of the algorithm and proposed model.

Accuracy computation

The algorithm's performance can be evaluated in terms of accuracy, sensitivity, and specificity. The confusion matrix defining the terms TP, TN, FP, and FN from the expected outcome and ground truth result for the calculation of accuracy, sensitivity, and specificity are shown in Table 1[19]

Table 3.1: Confusion matrix defining the term TN, FP, FN, and TN

Expected out comes	Ground truth		
	Positive	Negative	Row total
Positive	TP	FP	TP+FP
Negative	FN	TN	FN+TN
Column total	TP+FN	FP+TN	TP+FP+FN+TN

Where TP is the number of true positives, which is used to indicate the total number of abnormal cases correctly classified, TN is the number of true negatives, which is used to indicate normal cases correctly classified; FP is the number of false positive, and it is used to indicate wrongly detected or classified abnormal cases; when they are actually normal cases and FN is the number of false negatives, it is used to indicate wrongly classified or detected normal cases; when they are actually abnormal cases [20], all of these outcome parameters are calculated using the total number of samples examined for the detection of the tumor. The quality rate parameter accuracy is the proportion of total correctly classified cases that are abnormally classified as abnormal and normally classified as normal from the total number of cases examined [21, 22]. Formula to calculate accuracy is given below.

Accuracy (Quality parameter) = ---------- (1)

Ethical consideration

Ethical concerns and predicaments are not very unusual in patients of brain tumors as well as in its detection. It is important to have knowledge about principles plus theory of ethics for benefit of patients, like decisions of life plus death. The most top listed ethical principles take account of respect for sovereignty, fairness and beneficence. For solving

ethical questions, it is important to follow all these rules and principles relevant to the neuronology patients for example discussing prognosis or diagnosis. Quality image is provided for analysis and diagnosis purpose. These considerations of rules and principles will be in investigation as well as decision-making procedure for improving the capability to make meaningful choices.

Research limitation

This study will have following limitation

- All material of previous study will be between the duration of 2007 to 2017(last ten years)
- Limited number of dataset will be used for the experiment.
- The proposed model will be justified through the analysis tool of Matlab.

Summary

This chapter describes the research plan to complete this study successfully. A graphical representation illustrates all the phases clearly in part 3.1. According to this chapter part 3.2 describe the research methods of this study and 3.3 detail descriptions about data set will use in experiment.in part 3.4 represents the description of technique which will use on data set. Part 3.5 articulates about the software (analysis tool) will use for implementation. Results computation formulas are discussed in part 3.6. Next part 3.7 illustrates the ethical consideration.

Literature review

The need of **a**utomated and well organized system of brain tumor MR image classification and diagnosis has increased with accurate results for the proper directions of treatment (therapy and surgical planning). For this purpose, many studies have been proposed by different researchers which has provided good results with accuracy. This chapter will conclude by a brief discussion of previous work.

The researcher focused on getting the higher level of accuracy in this study [23] and based on two main parts. First part is feature extraction by using different methodologies like LTP (Local ternary pattern), Contourlet transform and curvelet transform. Second and main part is classification which has performed by DNN, a supervised learning technique. This hybrid method was implemented on the dataset of one thousand MRI images. Unlikely the other feature extraction methods discussed in this paper experimental result of DNN with Contourlet transform technique gives the higher level of accuracy with 97.5 %. In the minimum time span of 0.088 sec. On the other hand, curvelet transform technique has given equal results but computational was 0.15sec which is longer than previous. LTP (Local ternary pattern) has used fewer time span of 0.094 sec but accuracy level is very low to 18.33%. In the addition of time and accuracy, other performance evaluation parameters were also calculated like error rate, sensitivity and f-measure. All results have shown the DNN with the Contourlet transform combination the best technique.

A considerable work of the researcher [24] which expresses the experimental results based on two major parameters like time and accuracy. These parameters are helpful to prove the proficiency of the algorithm. This study, ultimately give a performance comparison of different algorithm like DNN, ANN and KNN. Experimental results and statistical analysis illustrate the percentage of accuracy which are 93.18, 90.90 and 81.81 respectively. According to the results it is very clear that DNN gave higher level of percentage as compare to other remain methodologies KNN and ANN. As a dataset for the experiment MRI images are used in this study but the significant point is that the fusion technique consists of Gray Level Concurrence Matrix features and classifier DNN, gave better result and higher level of accuracy.

Proposed work in this study [25] represents segmentation method which is helpful to facilitate users for quick and efficient tumors recognition of brain MRI. New method introduces a symmetry analysis with further consistent behavior in pathological cases. This methodology is applied on numerous datasets of different sizes of tumor, location and intensities and automatically detection and segmentation of different categories of

brain tumors with a higher quality. This methodology makes the doctors capable to find tumor in brain of patient and to compute the area of the tumor occupied in brain so that, an effective therapy and treatment can be planned. This goal is achieved successfully by following few steps in MATLAB coding for image processing. We were also able to segment the different part of the brain from the brain CT mages. After area calculation, it was seen that the value of area computing varies with the diverse slice of brain images.

The author [26], used SVM classification technique on brain MR images to classify into normal and abnormal. Matlab 7.9 has been used for implementation purpose to extract the features. Extracted results are used as an input for classification process to conclude the results of normal or abnormal. With the accuracy of 65% normal images are classified successful but abnormal images are not. The reason behind the unsuccessfulness is use of Radiant Basis Function (RBF) with classification. According to this study SVM cannot give trustworthy results with the large data.

While in this paper [27] author proposed a hybrid method in the combination of SVM with GA (genetic algorithm) to get higher accuracy. GA-SVM system is proposed for selection of features on the basis of texture and intensity, and multiclass classification. This system evaluated individual class accuracy and overall accuracy with the large dataset of 428 images (50% training dataset and 50% testing dataset). GA-SVM gave overall accuracy of 91%. According to the study accurate results or performance of the system depends on the proper selection of features.

In another study [28] MR Images are segmented using the technique of thresholding segmentation. Before segmentation process images are converted into gray scale images and then filter to remove the noise and brighter or sharper the images to get better output. SVM classification technique is used as a classifier which illustrate whether it is malignant, benign or normal.

This author [29] [33] [34] proposed LS-SVM as a classifier with the better performance. K-mean algorithm is used for image segmentation and features are extracted to reduce input and co-relation metrics are used for discrimination of normal and abnormal images. B using the KULeuven's MATLAB/C LS-SVM toolbox KULeuven's MATLAB/C LS-SVMlab toolbox SVM classifier give 95.23% accuracy, 100% sensitivity and 87.5% specificity.

According to this study [30] features are extracted through SURF and SIFT from MR Images. Images are classified by using KNN classifier. KNN with SIFT and SURF feature extraction give the accuracy of 96,22% and elapsed time is 1935.76 sec and with on SURF gives the accuracy of 94.33% and elapsed time 14.95 sec.

While another author [31] also used SVM classification technique. Dataset of 140 brain tumor MR Images are taken from internet brain tumor repository. Large dataset is used for detection tumor which gave comparatively improved results. Features are extracted on the basis of shape, intensity and texture. After performing the selection PCA and LDA are two analysis techniques which are used to reduce the features. Accuracy results have improved to 98.77%.

This paper [32] proposed FCM to identify tumor's grade value. By using soft computing scheme of fuzzy cognitive maps to represent and model expert's knowledge FCM grading model achieved a diagnostic output accuracy of 90.26% & 93.22 % of brain tumors of low grade and high grade respectively. This work proposed the technique only for Characterization and accurate determination of grade

While This work [35] [43] consist of two steps; first is plotting a spider web on the basis of wavelet entropy for the feature extraction, second is classification through the probabilistic neural network which is applied on extracted features. This proposed methodology has improved the classification accuracy to the 100%.

In this paper [36] [40] researcher used back propagation neural network technique for the classification. Wavelet transform is used to for feature extraction and PCA is used for feature selection so that reduced data is implemented to get better results. This method give the results if 100% accuracy in 0.0451s.

This study [37] revealed an automated system for brain tumor detection and classification.in this study all the algorithms are tested according to which no one can perform best for all brain tumor region considered. This study also reveals that fusing various semesters can boosts performance considerably.

This paper [38] proposed automated tumor detection system on the basis of knowledge based fuzz information. The method consists of four steps. Pre-processing data based on fusion which is the key step of this technique. Fuzzy classification gave the efficient results when information fusion is used as an input data.

This study [39] using the automated segmentation of MR Images using the fuzz C-mean clustering technique. Retrieved no. of images are 820. SVM classifier is used for classi-

fication purpose which is implemented MATLAB toolbox and improved the accuracy results to 97.95%. The system can be used as a diagnostic decision for the radiologist.

This study [41] used probabilistic neural network technique for the classification. PCA is used for feature extraction and selection so that reduced data is implemented to get better results. This method give the results if 73 % to 100% accuracy

This study [42] presents an innovative application of ANFIS as classifier for classification of MR brain image. The system implicates two main modules, one that performs classification and the other one that segment the tumors from the images. In the segmentation phase the system performed well and successfully detects the tumors in the images. Experimental result identifies that the classification application is workable with the accuracy of greater than 90%.

This study [42] introduced a new segmentation technique which is LaV deformation information for the features used as an input data set. This procedure affects the classification results.

While the author proposed work [45] of spectral clustering extension to ICA (SC-ICA) for multispectral brain MRI analysis. The algorithm is advanced because it covers problem of data mining problem, to excerpt small amount of details from background and other tissues which used spectral clustering, ICA and SVM. The Proposed system is calculated both quantitatively and qualitatively, for normal and abnormal cases. A comparison of ICA+SVM and other predictable classification techniques can be implemented. SC-ICA based SVM gives the better performance of brain tissue classification, particularly in the situation of small lesions and tumors. Though, the selection of threshold value plays an essential role in classified results (accuracy and reproducibility).

The combined wavelet-based texture analysis method proposed in this work [46] using the SVM classifier enables proper tumor segmentation, and the PNN classifier enables tumor classification thereby saving time and reducing the complexity involved with high sensitivity, specificity and accuracy.

This paper [44] [47] proposed a method in which supervised technique SOM (self-organizing maps) is used for classification. DWT (discrete wavelet transforms) is used for feature extraction. This method is implemented by using the MATLAB 7.1 toolbox and 94% accuracy is achieved.

Table 4.1 Tabular summary of previous discussed work

SVM classifier + Radiant Basis Function (RBF)

Limitations	Cannot work precisely when the data is large due to the training complexity of SVM itself which is highly dependent on the size of data
Data set type & total images	60 MRI 39 are successful 21 are fail
Accuracy / Results	65%
Experimental tool	MATLAB7.9
Author / study	Othman, Mohd Fauzi Bin, 2011

SVM classifier

Segmentation / Feature extraction technique	Spatial gray level dependence method (SGLDM)
Genetic algorithm	✓
Limitations	Having fresh training set whenever there is change in image database. It has been observed that the performance of the classifier depends upon the features selected.
Data set type & total images	428 brain tumor MR image
Accuracy / Results	Overall accuracy is 91%
Experimental tool	MATLAB software package 8.0
Author / study	Sachdeva, Jainy, et al., 2011

SVM classifier

Segmentation / Feature extraction technique	Threshold segmentation method on the basis of gray scaled into binary
Limitations	Lack of quantitative measures
Data set type & total images	MR image
Accuracy / Results	type of tumor is specified whether it is malignant, benign or normal
Experimental tool	MATLAB
Author / study	Vandhana, S., et al. 2015

SVM active learning approach

Segmentation / Feature extraction technique	Knowledge-based fuzzy algorithm
Limitations	Lak of quantitative measure of non-enhanced tumor area
Data set type & total images	MR Images (T2, T1and FLAIR)
Accuracy / Results	81%
Experimental tool	MATLAB
Author / study	Su, Po, et al., 2012

Advance LS-SVM

Segmentation / Feature extraction technique	Fuzz C-mean
Limitations	Stem could not achieve higher performance in retrieving most similar images
Data set type & total images	820 MR Images
Accuracy / Results	97.95%
Experimental tool	MATLAB
Author / study	Arakeri, Megha P.2012

KNN + SVM

Segmentation / Feature extraction technique	**PCA and LDA**
Limitations	Stem could not achieve higher performance in retrieving most similar images
Data set type & total images	820 MR Images
Accuracy / Results	97.95%
Experimental tool	MATLAB
Author / study	Arakeri, Megha P.2012

KNN

Segmentation / Feature extraction technique	SURF & SIFT

Limitations	Still accuracy is less than SVM
Data set type & total images	101 MRI 92→brain tumor 9→non-tumor
Accuracy / Results	96.22%
Experimental tool	MATLAB
Author / study	Amulya, Ch, and G. Prathibha, 2016

SOM (Self-Organizing Map)

Segmentation / Feature extraction technique	DWT (Discrete wavelet transform)
Data set type & total images	52 MRI of T2 weighted
Accuracy / Results	94%
Experimental tool	Matlab 7.1
Author / study	Chaplot, Sandeep, L. M. Patnaik, 2006

Fuzzy c-mean

Limitations	It runs automatically except for the choice of a volume of interest and seed point. A user verification step must be added to ensure the quality.
Accuracy / Results	96.5%
Experimental tool	MATLAB
Author / study	Lin et al 2005

BPNN (Back Propagation Neural Network)

Segmentation / Feature extraction technique	Wavelet transforms + PCA
Limitations	Lost the time information of the signal, classification decrease as the time information is lost
Data set type & total images	66 MRI
Accuracy / Results	100**%**
Experimental tool	Matlab 2009b (the mathwork)
Author / study	Zhang, Yudong, et al., 2011

NN (Neural Network)

Segmentation / Feature	PCA

extraction technique	
Limitations	Over discriminant accuracy is less. Determination of Unique feature vector is not possible
Accuracy / Results	73**%**
Author / study	Sumitra and axena 2013

PNN (Probabilistic Neural Network)

Segmentation / Feature extraction technique	Wavelet Entropy
Limitations	When there is increase in image database fresh training in required
Data set type & total images	T2 weighted 75 MRI
Accuracy / Results	100**%**
Author / study	Saritha, M., K. Paul, 2013

DNN (Deep Neural Network)

Segmentation / Feature extraction technique	Contourlet transform
Limitations	Accuracy level can be increased more
Data set type & total images	1000 MRI images 256 x 256
Accuracy / Results	97.5**%**
Author / study	A. Anbarasa Pandian and R. Balasubramanian November 2015

DNN (Deep Neural Network)

Segmentation / Feature extraction technique	Gray Level Concurrence Matrix features
Limitations	Accuracy can be increased more if time span is ignored
Data set type & total images	2D MRI Images
Accuracy / Results	93.18%
Author / study	P. Rajkumar*1, Y. Justin dhas2 April - June 2017

Through the previous discussion we have accomplished a partial survey of various classification techniques for MRI brain image which followed supervised learning, unsupervised or semi-supervised learning. A comparative study is made on various techniques. After evaluation of well-known technique, it is clearly shown the various methods which can detect the tumor efficiently and provide accurate result. But the methods which have been focused been by our researchers are supervised techniques with high accuracy and unsupervised techniques are not being used mostly until now. Now researchers are moving toward the Semi-supervised techniques to develop the automated system. Supervised technique gives highest level of accuracy among all according to analysis.

Table 4.2 comparison of different technique

Accuracy of Classification Techniques Type of learning Techniques	SVM (support vector machine)	KNN (K nearest neighbor)	SOM (Self-organizing map)	NN (neural network)	Fuzzy c-mean	PNN (probabilistic neural network)	BPNN (back propagation neural network)	DNN
Supervised		96.22%		73%	96.5 %	100%	100%	97.3 %
Unsupervised			94%					
Semi-supervised	95%							

Summary

This chapter describes the efforts of the previous researchers by using the different technique and other methods. All the previous work is summarized in a table.

Proposed work and implementation

Image analysis system provides an efficient way to analyze the medical image and detect the abnormalities of those images. This analysis system will able to reveal more possible aspect of images by applying the grey scaled segmentation with the advance classification technique of neural network which is DNN (deep neural network). This experiment provides the best combination for image analysis system. The graphical representation of proposed work is given below.

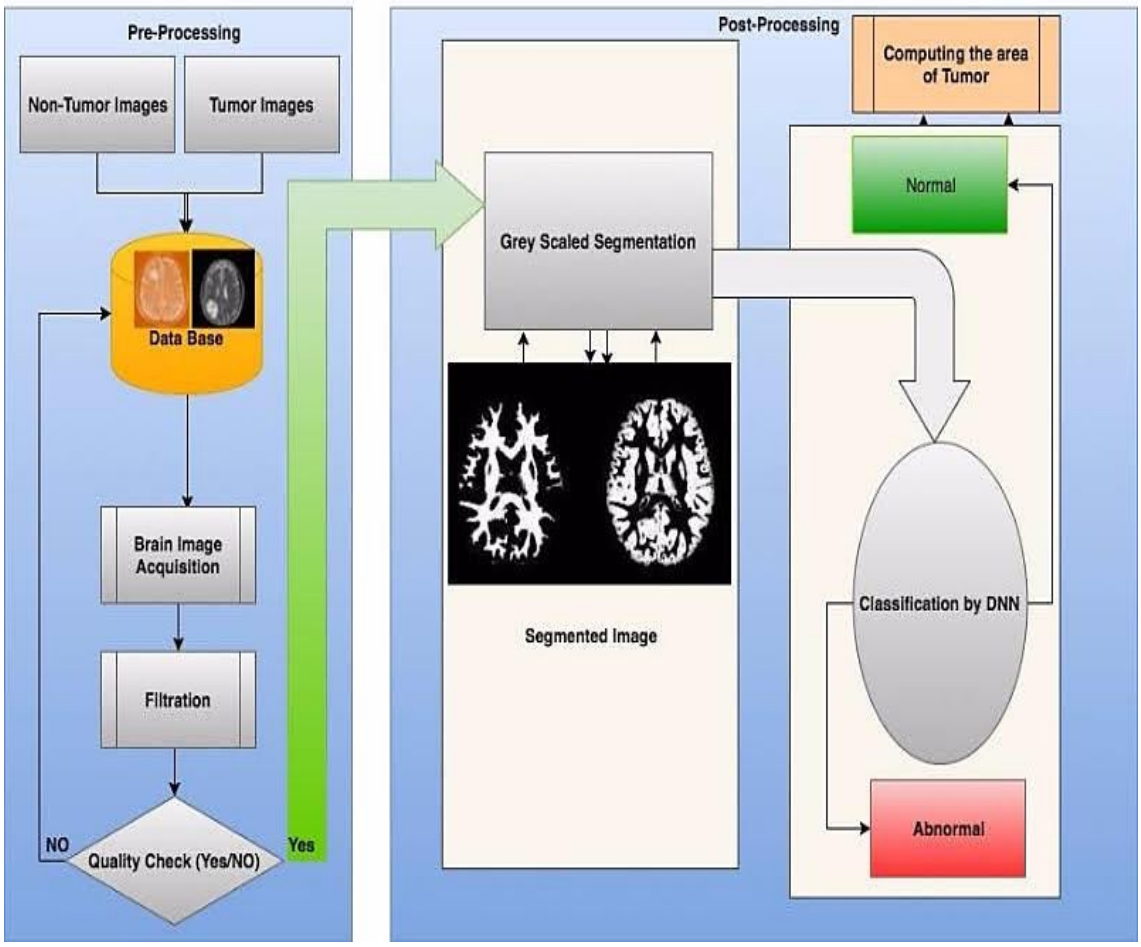


FIGURE 5.1 Graphical representation of proposed work

Description of proposed work

The proposed work is divided into two parts**.** First is pre-processing and second is post pro-processing. Dataset of brain MR Images are using as an input. For the implementation 10 brain MRI images are used in which also contain non-tumor and tumor affected images. The format of downloaded images is in .gif however needed to convert it in .png format so that it can be easily used by Matlab environment.

Pre-processing

In the first part, the input of MR Images is picked from database.

Step 1: Apply filtration (by using Matlab command) process on images to minimize the noise from the image

Step 2: Check the quality of image. If quality of image is not good, then reject that image and pick another image from database. If yes, then further processing is started and move to the next part.

Post-processing

The output of the previous step is used as an input of the post-processing part.

Step 2: The filtered image is proceeded for the grey scaled segmentation by Matlab command

Step 3: the process of resizing image into 200 X 200 image matrix.

Step 4: Move image for classification

Step5: deep neural network technique is classified the image into tumor par and non - tumor part.

Step6: If image contain tumor then move for further process of computing area.

Area calculation

Step7: Classified tumor part of the image is using as an input

Step8: convert the image into pixels

Step9: Compute numbers of rows and column in pixels by

[r2 c2] = size (I)

Step4:- Initialize a variable a=0

Step4:- For i=1:1:r2 do

Step4:- For j=1:1:c2 do

Step4: - If I (i,j)==255 do

Step4:- a=a+0

Step4:- Else do

Step4:- a=a+1

Step4:- EndIF

Step4:- EndFor

Step4:- End For

Step4:- Display the area.

Implementation results

The results are shown in the Matlab windows step by step as discussed before in 5.1.

FIGURE 5.2 represents the starting window and can be viewed after pressing the refresh button.

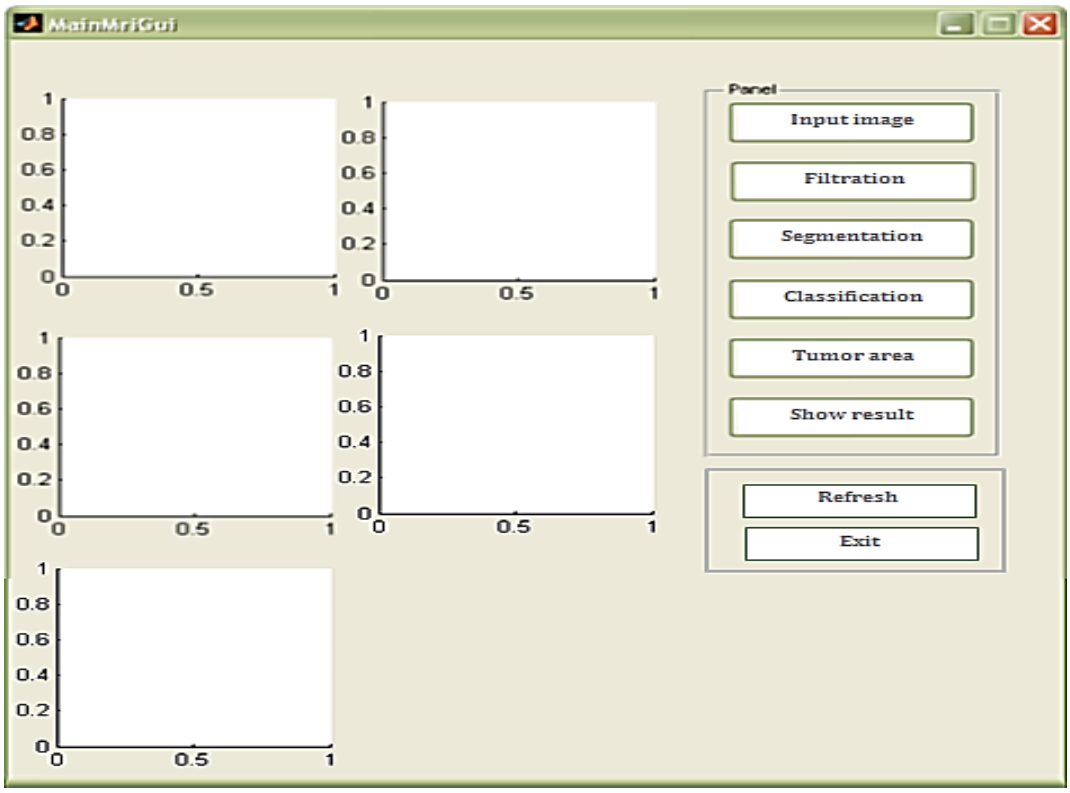


FIGURE 5.2 Starting window or after refresh window.

FIGURE 5.3 represents the second step where brain MRI image is retrieved from database and can be seen in the Matlab window as an input image.

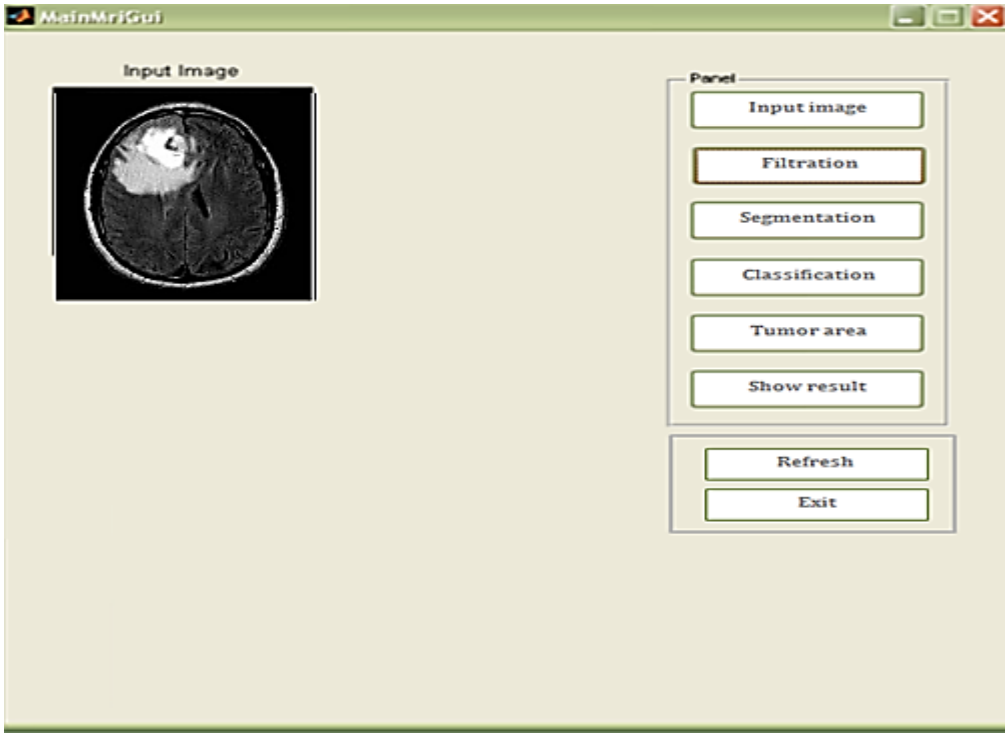


FIGURE 5.3 Retrieved input image

Next step show in the FIGURE 5.4 in which filtration is applied on the input image and result is shown in the enhanced filter image.

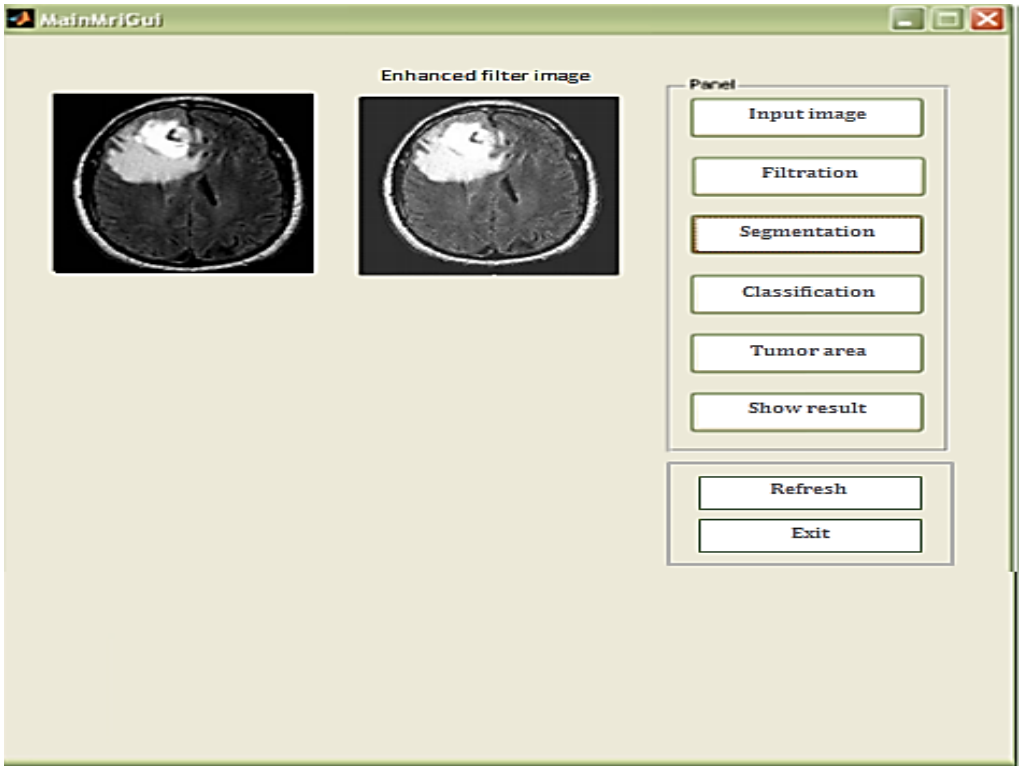


FIGURE 5.4 Enhanced filter on image.

Next step is image segmentation by the gray scaled technique which is show in the FIGURE 5.5 and classified image is shown in Matlab window in FIGURE 5.6.

FIGURE 5.5 Gray scaled segmented image

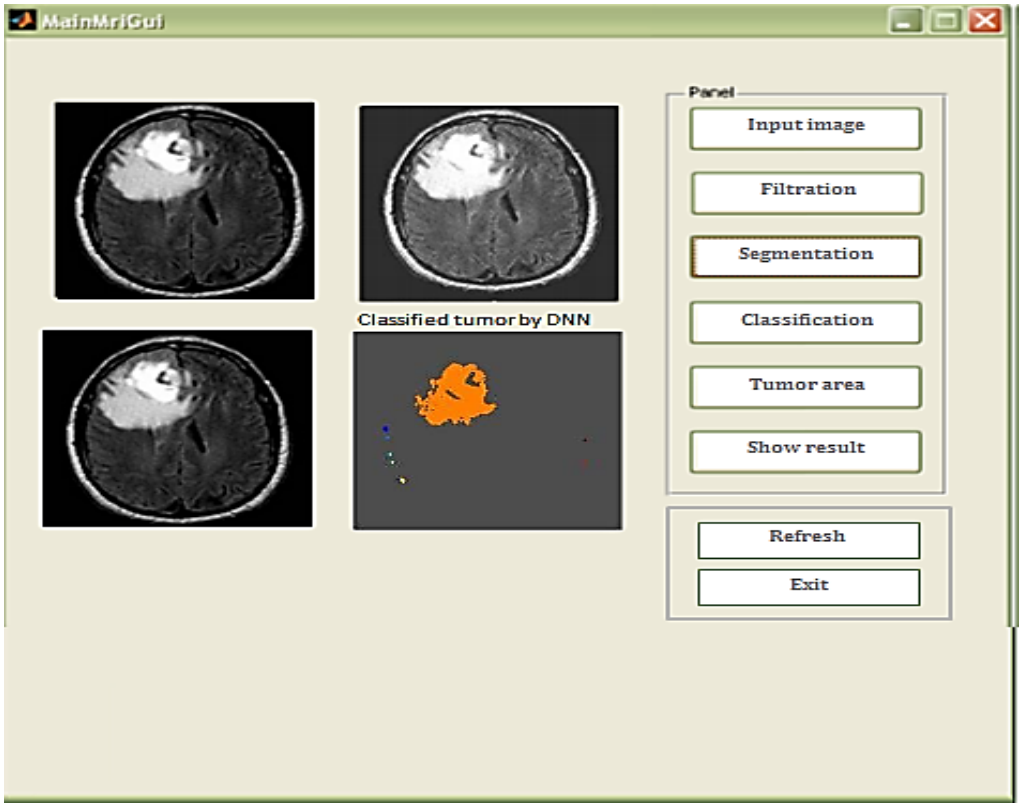


FIGURE 5.6 Classified tumor by DNN

FIGURE 5.6 Matlab 4th image window shows the classified tumor by DDN in matlab

Last step is calculating the area of the classified image and the show calculation results in text box on clicking the button ‘show result’ as shown in the FIGURE 5.7.

FIGURE 5.7 tumor area in the last image window box with the calculated area in text box.

Image analysis system can recognize the non-tumor brain MRIs. FIGURE 5.8 represents the result in the case of brain image does not contain the tumor.

FIGURE 5.8 Non-tumor Brain MRI images

Efficiency of the classification results

The proficiency of the proposed algorithm is calculated with the help of predictive value and result of the images after experiment. Accuracy is also is computed by usinf the formula (already discussed in chapter 3 equation 1)

Table 5.1 predictive values and output values

statement	True	False	Total
positive	**6 [TP]**	**0 [TN]**	**6**
Negative	**1 [FP]**	**3 [FN]**	**4**
Total	**7**	**3**	**10**

Accuracy (Quality parameter) = ---------- (1

= 6+3/6+0+1+3

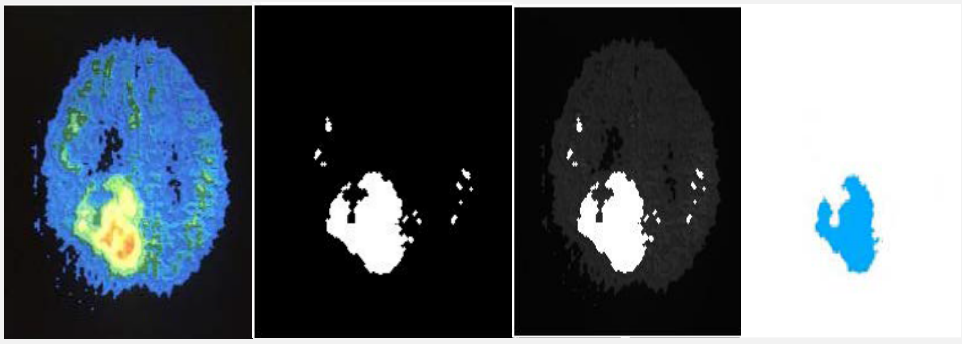
=9/10

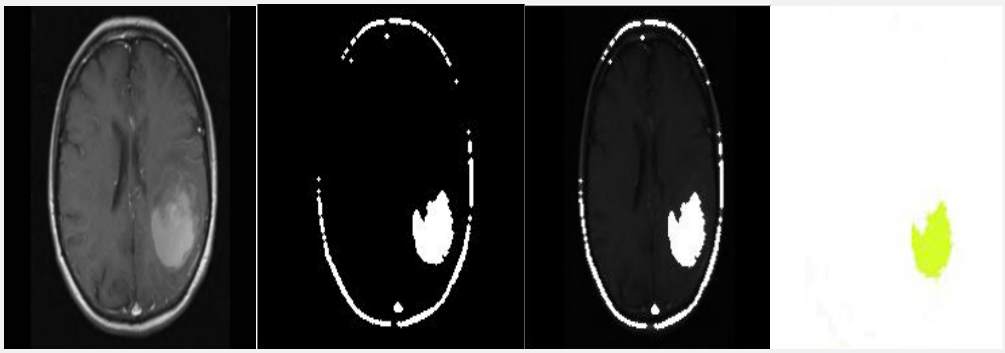
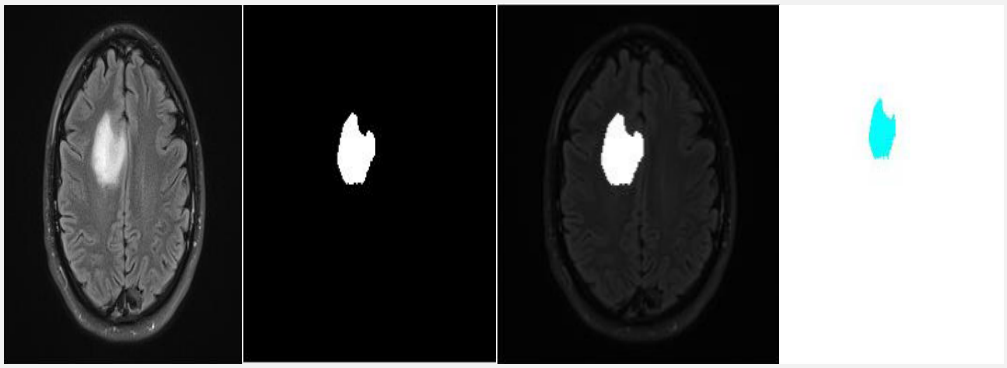
= 0.9*100

= 90%

90% accuracy of the classification has computed by DNN algorithm and in next step computing the area of tumor which have discussed already result is given in the table5.3

Table 5.2 Results of experiment in a sequence

Image name	A1	A2	A3	A4
BT2				

BT3	
BT4	

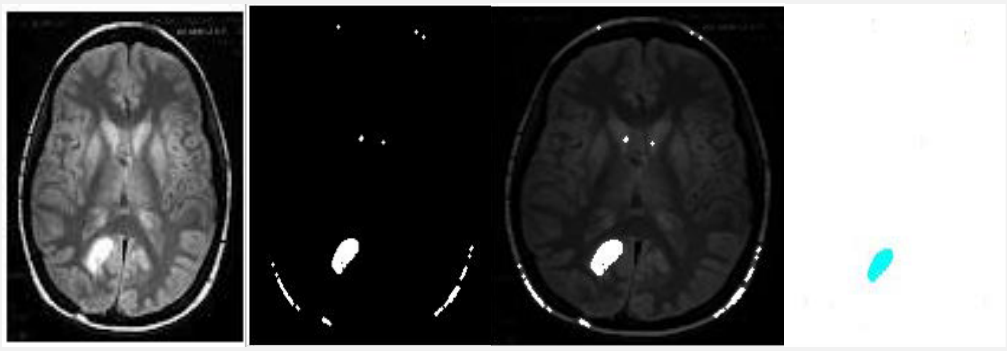
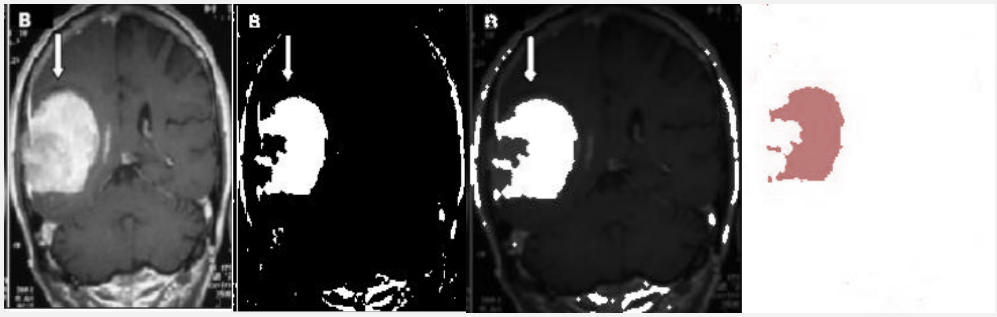
BT5	
BT6	

Table 5.2 shows the results of remaining 6 images in a sequence of input image, filtered image, segmented image and classified image. The following table 5.3 shoe the area of tumor which have detected as a tumor affected image

Table 5.3 Result of tumor calculated area

Image name	Image size	Tumor size
BT1	200×200	6040
BT2	200×200	5080
BT3	200×200	4913
BT4	200×200	2144
BT5	200×200	2778
BT6	200×200	8808

Summary

This chapter describes the proposed method and implementation in the Matlab tool. Preprocessing steps, post processing steps and calculation of classified tumor, all step are show in Matlab window with their results in the form of screen shorts.

Conclusion and future recommendation

In this dissertation, an experiment has been conducted to detect the tumor from the MR images. Image filtration has been used to improve the quality of image, next step is image segmentation which has given better results of the image and the output of the segmentation has used as an input image to the classification process.as well as the survey have conducted of different techniques which are used for the purpose of classification of brain tumor MR image.

Dataset consist of 10 images of tumor and non-tumor.

In this study, a model has been proposed for the efficient tumor detection of brain MR images. Following steps are adopted for detection.

Step 1: taking input image.

Step 2: filter image.

Step 3: segmentation of MR image by gray scaled technique.

Step 4: and then apply classification technique of deep neural network to detect the tumor from brain MR images.

Accuracy of the classification is 90% which is calculated by using the formula.

Step 5: last task is to compute the area of the detected image by using algorithm.

1.1 Future recommendation

Researchers are needed to give attention to improve the procedure of tumor detection by using the different form of neural network. It would be curious to explore the behavior and output of the different form of neural network like ANN, CNN, PNN, DNN and simple neural network by using smaller number of labeled images to perform well. Different parameters would be used for this investigation like accuracy, time, specificity, efficiency and many others. There is need to introduce an automated expert system which can identify the tumor at its earlier stage so that a better planning could be organized for treatment.

1.2 Summary

This chapter concluded the result of work and experiments of the whole thesis.

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