BRAIN TUMOR DETECTION USING PSO AND TEXTURE ANALYSIS OF MRI IMAGES USING PCA FOLLOWED BY ICA

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE
OF

MASTER OF TECHNOLOGY
IN
SIGNAL PROCESSING AND DIGITAL DESIGN

Submitted by:

SAKSHI BHANDARI

2K17/SPD/12

Under the supervision of

Dr. M.S. Choudhry

ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Bawana Road, Delhi-110042

JUNE, 2019

BRAIN TUMOR DETECTION USING PSO AND TEXTURE ANALYSIS OF MRI IMAGES USING PCA FOLLOWED BY ICA

A PROJECT REPORT

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE
OF

MASTER OF TECHNOLOGY
IN
SIGNAL PROCESSING AND DIGITAL DESIGN

Submitted by:

SAKSHI BHANDARI
2K17/SPD/12

Under the supervision of

Dr. M.S. Choudhry

ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT
DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Bawana Road, Delhi-110042

JUNE, 2019

ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Bawana Road, Delhi-110042

CANDIDATE'S DECLARATION

I, Sakshi Bhandari,2K17/SPD/12 student of M.Tech (ECE,SPD), hereby declare that the project Dissertation titled "Brain Tumor Detection Using Particle Swarm Optimization & Texture Analysis Of MRI Images For Brain Tumor Detection Using PCA followed By ICA" which is submitted by me to the Department of Electronics and Communication Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

Place: Delhi **Sakshi Bhandari**

Date:

ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Bawana Road, Delhi-110042

CERTIFICATE

I hereby certify that the Project Dissertation titled "Brain Tumor Detection Using Particle Swarm Optimization & Texture Analysis Of MRI Images For Brain Tumor Detection Using PCA followed By ICA" which is submitted by Sakshi Bhandari,2K17/SPD/12,[Electronics and Communication Dept.], Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi **Dr. M.S. Choudhry**

Date: **SUPERVISOR**

ACKNOWLEDGEMENT

I would like to express my gratitude towards all the people who have contributed their precious time and effort to help me without whom it would not have been possible for me to understand and complete the project.

I would like to thank Dr. M.S Choudhry, Department of Electronics and Communication Engineering, my Project guide, for support, motivation and encouragement throughout the period this work was carried out. His readiness for consultation at all times, his educative comments, his concern and assistance even with practical things have been invaluable.

ABSTRACT

Brain tumor segmentation and MRI image analysis is one of the crucial procedures in surgical and treatment planning. Brain tumor segmentation using MRI has been an intense research area. Brain tumors can have various sizes and shapes and may appear at different locations. Brain tumor segmentation consists of separating the different tumor tissues. The method proposed for analysis is segmentation using PSO and analysis through texture feature reduction PCA followed by ICA. In our project we will be using Particle swarm optimization method for image segmentation as it is swarm intelligence based method and so a better optimization technique for segmentation. For tumor detection and analysis, texture or shape analysis can be done. Here we will be using texture analysis for the detection of tumor in brain. In our project we will be extracting GLCM features and then reducing the feature set using PCA followed by ICA. The reduction of features is done in order to reduce the complexity and redundancy as the features obtained are large in number. The classification will be done using SVM and different parameters like accuracy and time will be computed in order to compare with other methods that were being used earlier like PCA, LDA etc. The technology used in our project for implementation MATLAB 2015.

TABLE OF CONTENTS

List of Figures

List of Tables

List of Symbols, Abbreviations

Sno.	Abbreviations	Description
1.	PCA	Principal Component Analysis
2.	ICA	Independent Component Analysis
3.	SVM	Support Vector Machine
4.	IC	Independent Components
5.	NN	Neural Network
6.	MRI	Magnetic Resonance Imaging
7.	GLCM	Gray Level Co-occurrence Matrix
8.	GA	Genetic Algorithm
9.	PSO	Particle Swarm Optimization
10.	LDA	Linear Discriminant Analysis
11.	PC	Principal Component
12.	UI	User Interface
13.	BSS	Blind Source Separation

CHAPTER1

INTRODUCTION

1.1 Introduction

Brain tumor division and MRI image examination are commonly used and essential methodologies in cautious and treatment orchestrating. Brain tumor or lesion division using MRI or CT images has been an excellent research an area [1]. Tumors or lesions that exists in brain can be of various sizes, shapes and volumes and they may exist at different part of brain tissues. Brain tumor division contains segregating the particular tissues (solid or dynamic tumor, edema, and defilement) which are tumor affected from customary mind tissues: Gray matter (GM), white matter (WM), and cerebrospinal fluid (CSF)[2]. In tumor contemplates, the nearness of surprising tissues may be viably perceptible as a general rule. Changing intensity, sizes, volumes of tumors in mind alluring resonation images (MRI) makes the customized division of tumors inconceivably testing. There is diverse power based strategies which is proposed by many researchers in order to parcel tumors on appealing resonation images. In Biomedical Imaging, Image division assumes and significant job in investigation, upgrade and show of images caught through x-beam, ultrasound, MRI, atomic machine and optical imaging strategies. The customary strategy for CT and MRI brain images grouping and tumor recognition are still for the most part in light of an immediate human investigation of those images, in spite their being various other diverse techniques have just been proposed [3,4]. There are numerous procedures that can be used for image division and segmentation. Generally utilized techniques are Thresholding, Seeded region algorithm, k-Means clustering [5,6] and so on. All strategies have their points of interest and detriments. The strategy we will use for division is Particle Swarm Optimization[7] which is stochastic molecule put together technique based with respect to best estimation of molecule. The multi fractal surface estimation systems are extra dreary. In the wake of fragmenting the image we will examine the kind of tumor by means of surface feature examination. For investigation we can utilize surface, shape. and so on features. In our undertaking we will utilize surface or texture feature for tumor investigation. In our project we will be extracting, Gray-Level Co-Occurrence Matrix i.e., GLCM textures features listed below is given to different classifiers and mainly with SVM classifier is filed and different parameters are calculated. From the MRI images of brain, the perfect surface features of brain tumor are detected by utilizing GLCM Haralick's features [8]. We will be extracting the features and then reducing the size by feeding the feature set to PCA so that redundant features can be reduced and eliminated. As we reduces the number of accuracy it may lead to reduction of accuracy due to reduction of some required features and therefore, we will apply ICA in order to increase accuracy. Then, by using these features SVM classifier will divide the features into tumor affected or non-tumor tissues and hence, afterwards the tumor is divided into two classes. This methodology gives progressively

gainful brain tumor division stood out from the division technique reliant on and will give dynamically correct result.

1.1.1 What is tumor?

Tumor or malignancy is defined as abnormal headway of the tissues. A brain carcinoma or tumor is a mass of superfluous cells that is made in the brain or some tissues like spinal or medulla. Brain malignancy can be considered as a certified bit of the most savage and fervent burdens. Today, mechanical gatherings and techniques to isolate tumors and their direct are curving up logically otherworldly. Obviously, a few endeavors had made over the prior century which have yielded genuine advances. In any case, we have to understand and come to the conclusion in order to update and come up with a treatment and technology that can be used to medical analysis. Notwithstanding the path that regardless of all that we can't fix mind tumors, clear strolls forward have been taken toward achieving this over the top focus on, a reliably extending number of specialists have hardened measures into clinical preliminaries to the general population who live with this end. Attractive Resonance Imaging (X-ray) has changed into an overall utilized method for remarkable restorative imaging, particularly in cerebrum imaging where X-ray's delicate tissue discrete and non-noticeable quality are clear tendencies. An essential utilization of X-ray information is following the level of cerebrum tumor as it reacts treatment. The accompanying figures are instances of Tumor influenced Brain X-ray pictures (Source: www.google.com)

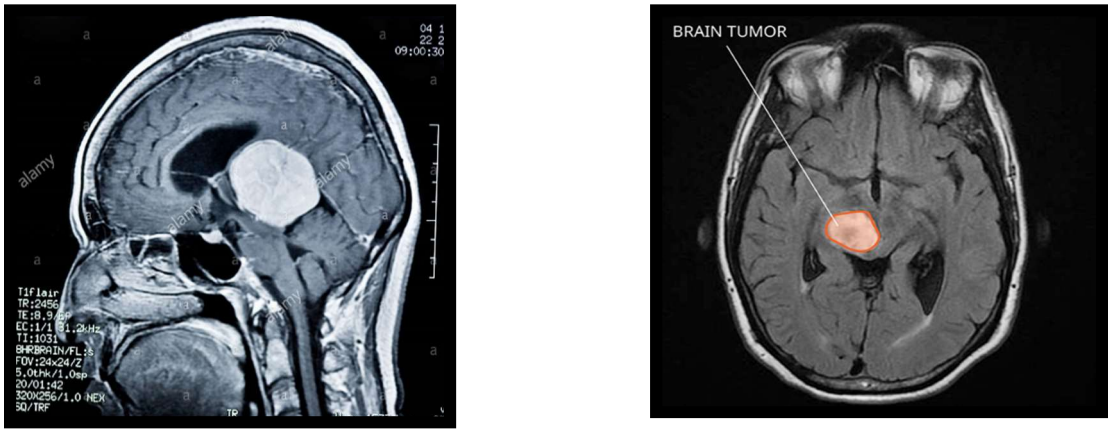

Fig 1: Tumor effected MRI images

Along the lines, a changed and solid technique for confining tumor would be a valuable device. X-shaft gives a modernized delineation of tissue or cells characteristics that can be gotten in any tissue plane. The photographs made by a X-ray scanner are best delineated as cuts through the mind [9]. X-beam has the additional favored perspective of being able to pass on pictures which cut the brain area in both even horizontal and vertical planes. This will make X-ray channel pictures a perfect hotspot for perceiving, seeing and assembling the advantage corrupted locales of the mind. The proposed structure presents a system by

which cerebrum tumor can be perceived and allocated. The technique will extract GLCM based texture feature extraction and Support Vector Machine as a classifier for the division of cerebrum tumor in MR pictures. Examination with broad number of components requires a lot of memory and calculation control. So fuse extraction is done to conquer this issue. Here the GLCM structure is made for highlight extraction and the highlights along these lines secured are utilized for social occasion tumor and non-tumor pixels utilizing SVM classifier. The varying features or highlights extraced from the GLCM grid unite Complexity, mean, contrast, Entropy, Homogeneity, and so on [8]. Decreasing of model dimensionality utilizing highlight extraction is a hero among the most essential strides for depiction process. Highlight choice has besides expansive significance in zones, for example, bioinformatics, flag managing, picture arranging, content request, information mining, structure certification and therapeutic end. The reason for highlight choice is to pick a subset of accessible highlights by killing less fundamental or superfluous highlights. To confine in any case much data as could be ordinary from a given set while utilizing less highlights, the highlights with by zero farsighted data is to be executed, and steadfastly contrasted dull highlights are with be disregarded. Consequently, a lot of calculation time can be spared with a profitable subset. The picked subset of highlights used to address such demand work impacts a few pieces of depiction, including the time required to get settled with a course of action work, the exactness of the educated assembling calculation, the time-space cost related with the highlights, and the quantity of tests required for arranging.

A brain tumor or lesion are defined as cyst or unpredictable cell structure that is visible inside the brain. There are different stages of tumors and therefore tumor or cancer is generally classified as benign or malignant. Threatening lesions will be segregated in basic/benign or malignant tumors that initiated inside the brain and those are escalate ed from somewhere are malignant tumors. Brain malignancy may convey symptoms that move dependent upon the bit of the brain included and there are number symptoms that can be looked in order to check and for MR analysis. Some of the symptoms can be anxiousness, neuralgia, seizures, issue with vision, heaving, and mental changes. The cerebral torment is generally most exceedingly dreadful in the initial segment of the day and leaves with hurling. Progressively unequivocal issues may consolidate inconvenience in walking, talking and with sensation. As the ailment increases conspicuousness may occur.

Brain malignancy tumors are defined as erratic and uncontrolled expansions of cells. Some begin in the mind itself, wherein case they are named essential. Others spread to this zone from elsewhere in the body through metastasis, and are named optional. Essential mind tumors don't spread to other body objectives, and can be perilous or tolerant. Optional character tumors are constantly ruinous. The two sorts are maybe weakening and risky. Since the space inside the skull is obliged, their improvement expands intracranial weight, and may cause edema, diminished circulatory framework, and movement, with coming about degeneration, of solid tissue that controls basic points of confinement. Cerebrum

tumors are, believe it or not, the subsequent driving reason behind compromising advancement related passings in youngsters and youthful grown-ups. A mind tumor is a mass or improvement of unpredictable cells in your cerebrum. A wide scope of sorts of cerebrum tumors exist. Some cerebrum tumors are noncancerous (kind), and some mind tumors are hazardous (undermining). Brain tumors can begin in your mind (fundamental cerebrum tumors), or danger can begin in various bits of your body and spread to your cerebrum (helper, or metastatic, mind tumors).

The tumors in the in the brain is detected and the treatment is based on the type of tumor detected the type of cancer in brain. The reaction and aftereffect of malignancy change enormously and rely upon the brain tumor's size, area and cost of development. Common signs and indications brought about by tumors that exist in brain may include:

- New beginning or change in example of cerebral pains
- Hemicrania, migraine that increases continuously and become progressively extreme
- Inexpressible queasiness or retching
- Sight issues, for example, obscured vision, twofold vision or loss of fringe vision
- Gradual loss of sensation or advancement in an arm or a leg
- Difficulty with equalization
- Speech and throat troubles
- Confusion in ordinary issues
- Personality or conduct changes
- Seizures, particularly in somebody who doesn't have a background marked by seizures
- Hearing issues

1.1.2 Image Segmentation in Biomedical Imaging

Image segmentation is the process which subdivides the image into its regions which are more meaning and useful for further analysis. We will be using image segmentation as a pre-processing method and makes it simpler to study. The extent of characteristic to which division is carried out is very important to analyze as it will allow to increase accuracy via segmentation and therefore, segmentation should stop when ROI or required objects is detected. The partitioned and segregated images or regions should have same color, intensities or textures. The pixel should share some visual characteristics that can be visible to analyze. The consequences and results of image division is a lot of locales which spread the whole picture. Every one of the pixels in an area are comparative as for certain qualities, for example, shading, power or surface. In light of this area we perceive how the district is divergent with its neighbor. As a standout amongst the most significant errands in biomedical imaging, picture division gives the establishment to quantitative thinking and

demonstrative strategies. A huge wide range of imaging procedures, each with its very own physical standard and qualities (e.g., clamor demonstrating), regularly requires methodology explicit algorithmic treatment [10]. The accompanying figures shows and case of cerebrum X-ray picture and its portioned picture [10]

Fig 2(a) : Original MRI Image

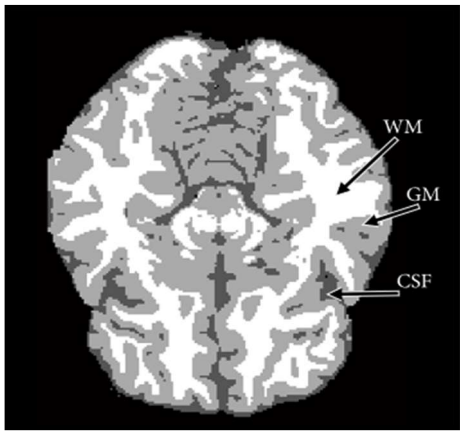

Fig 2(b) : Segmented MRI Image

There are number of methods that are used in the past for image segmentation like thresholding, region growing method, Otsu Algorithm etc. As technology grew, the disadvantages with these methods came into image.In real world and biomedical imaging, image segmentation problems have many objectives like as given below:

1. Minimize and decrease the features
2. Find meaningful information
3. Reduce overall deviation,
4. Reduce the error rate of the classifier and increase accuracy
5. Increase connectivity

There are number of image segmentation techniques that ae generally used in image processing. The methods which are commonly used in image processing are given below and drawbacks associated with them are also stated :

1. Thresholding: In this method we find an threshold value and according to a threshold value we will divide the image into two or more classes. Thresholding can be of two levels or multilevel. The drawback associated with thresholding is that it isdifficult to choose appropriate threshold value for thresholding method. Another variation used of global thresholding method is Otsu Thresholding in which a within class variances and inter class variances has to be calculated.
2. Seeded Region Growing Method: i. Choice of similarity criteria for pixels
   ii. Second problem how to select pixels

3. Fuzzy C- Means : In this a fuzzy function is chosen and that choice of membership function can be computationally expensive and complex.

As all the methods studied above are now obsolete and shows number of disadvantages so lately, considerable advancement has been made to biomedical picture division. Image division is the way toward parceling a computerized image into various fragments whose objective is to rearrange and change its portrayal into something that is increasingly important and compelling for examination. In biomedical imaging, doctors need to dissect the MRI, Ultra-sound, X-beam images, for that they need just significant data to consider. In this way, image division is utilized with the goal that lone significant data is extricated and utilized for finding. A noteworthy strain of therapeutic image examination through image division is high inconstancy in medicinal image as we as a whole know human life systems itself demonstrates a great deal of varieties, in this way aftereffects of division can be utilized get indicative experiences. Along these lines, as in our task we will utilize Particle Swarm Optimization as image division strategy for further investigation for recognition of tumor. The accompanying figure is a scrap from our venture which shows PSO segmented image.

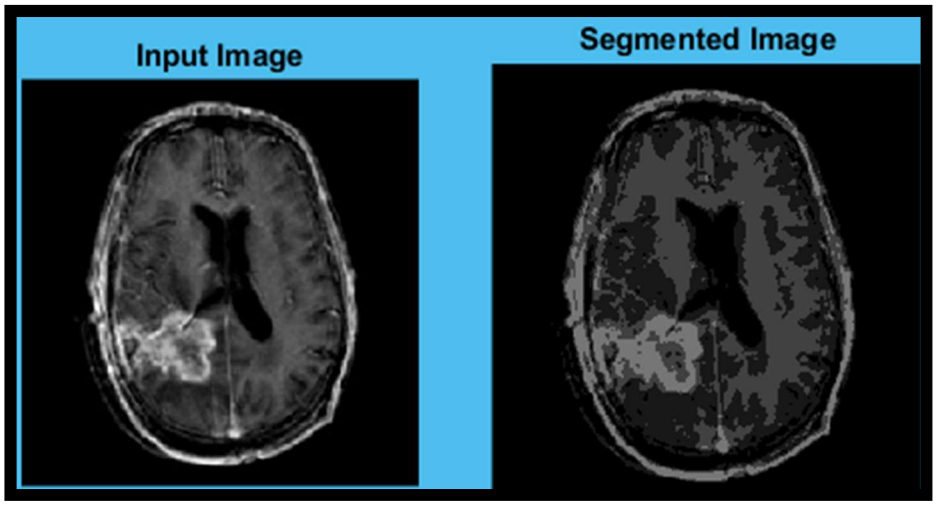

Fig.3: PSO Segmented Image

PSO is an evolvement measurement method which is developed by Kennedy and Eberhart in 1995 [7] which is population dependent method used for resolving the discrete optimization issues. PSO is a natural technique of calculating and optimizing and it provides a vast number of ways for solving the real world problems more efficiently and effectively with accuracy. The images segmented using PSO are well divided into regions of homogenous and regular color and are divided into more meaningful to human's vision and detect into well number of segments [11,12]. The Particle Swarm Optimization (PSO) is conceptual in technical research and engineering which is based on swarm intelligence. The searching and calculating is carried out with the speed of the particle with no mutation

computation and no overlapping is to be detected. The optimization of particle and most optimist particle that can transmit information on other particles and the speed is seen to be very high and effective through the latest generations. The prime objective of this work is to extract the tumor in the brain separately. This work notes the tumor in MRI image, and classify whether it is benign or malignant. PSO is used as method of segmentation in our project. Earlier, other methods like thresholding, region growing, K-Means clustering algorithm etc were used as segmentation of biomedical images. All these methods have their own disadvantages like in thresholding it is difficult to choose an optimum value of threshold, in K-means algorithm the value of K needs to be optimum and it is computationally expensive to calculate the membership functions.

Why PSO is better than other methods?

In image processing, image segmentation problems have many objectives like as given below:

1. Reduce the features
2. Decrease the overall deviation,
3. Reduces the error rate of classifier
4. Maximize and increase connectivity

The advantages of using PSO as segmentation method are :

1. Insensitive to scaling of design variables
2. Simple Enactment
3. Easily parallelized of simultaneous processing
4. Derivative free
5. Very less algorithm parameters
6. Efficient and effective search algorithm globally

As everything we use may not only have benefits; There are some drawbacks of using PSO as image segmentation algorithm and they are as follows:

1. Tendency to a fast and premature convergence in mid optimum points
2. Slow convergence in refined search stage (weak local search ability)

Therefore, we have seen that PSO is the natural technique of computing and provides huge number of ways for resolving the real world issues more efficiently and effectively with accuracy. The images segmented using swarm optimization are well segmented and divided into regions of regular, homogenous, color and meaningful information extracted. and can detect, automatically, very well the number of regions [36]

1.1.3 Image Texture Analysis

Texture analysis refers to the characterization of regions in an image by their texture content. Texture analysis attempts to specify built-in qualities described by terms such as rough, smooth, silky, or coarse as a function of the spatial variation in pixel intensities. Basically, all these properties are based on pixel's intensity variation or gray levels. It is used in various applications, including remote sensing, automated inspection, and bio-medical image processing. It can be used to find the texture boundaries, called texture segmentation. This approach has its application when objects in an image are more characterized by their texture than by intensity, and traditional thresholding techniques cannot be used effectively. In biomedical image analysis, for detection of tumor or any lesions texture or shape features can be used [13,14]. The following image gives an idea how texture will be used as one of the important parameters in clinical world for the detection of tumor and lesion. The following MR image is shown with different types of features that can be extracted i.e., shape, intensity, texture, etc. [15]

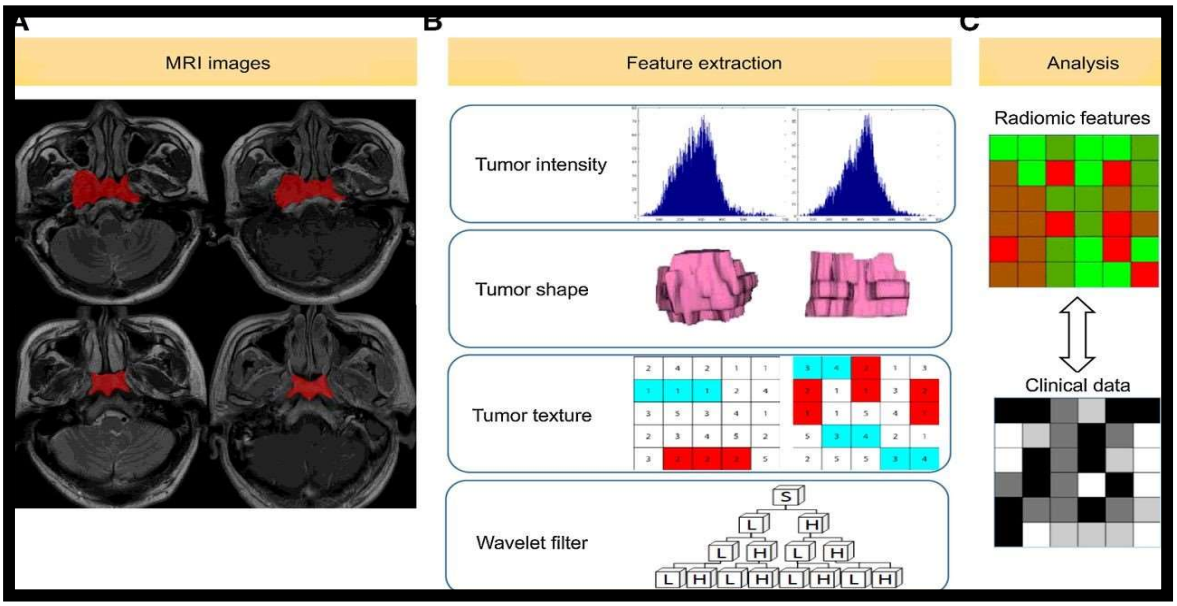

Fig. 4: Showing Analysis of MR Images for tumor detection A. Image Segmented image B. Features are extracted from within tumor defined regionC. For Analysis the features are compared with clinical data

Features are an important parameter to be looked into as they are the primary input to classifiers which will assign the class they will represent for. Feature extraction techniques enable to reduce the original data by measuring certain characteristics of image which will have only relevant data or features which will distinguish one pattern from another. There are various types of features that can be extracted and can be used for analysis for MRI brain tumor . The types of feature can be texture based ,shape based, intensity based, texture based etc. There can be number of techniques by which feature can be extracted like GLCM,

Gabor filter, Run length coding, fractal texture analysis, etc. The features are broadly classified into statistical and spectral features [16].

Different Feature extraction Techniques :

1. GLCM : Gray level Co-occurrence matrix features are broadly used for representing the statistical texture feature over spatial domain. It is used as powerful tool for texture analysis. Features produced using this method are known as Harlick's features et al. [8].
2. Gabor Transform or filter: Gabor filter is significantly used for extraction of features from images. The wavelets are in the form of sine wave modulated by a gaussian coefficient. The features are used for texture analysis and provides and optimal resolution in time and space domain [17][18].
3. SIFT : Shift invariant feature transform is used for finding local features which is invariant to scaling and rotation[19].
4. Statistical Features: Textures represents repletion of certain primitive. The statistical parameters for texture analysis refers to mean, variances , skewness which can be used for texture analysis.A general approach that is seen for statistical texture analysis based on statistical characteristics that is the intensity distribution of area which is given by histograms or n^{th}moment of mean[20]:

$$M_x = \sum_{j=0}^{L-1}(j-u)^x p(j) (1)$$

Where L-1 is maximum intensity value of image;j= independent variable for intensity; p(j) is normalised histogram in ROI ; u is mean value given by

$$u = \sum_{j=0}^{L-1} j.p(j) (2)$$

We will be using GLCM texture features for analysis. There will be number of textures features that will be extracted via this method. Textures based features will be obtained using GLCM matrix since we are interested in statistical Haralick's features [8]. The advantage of using texture feature attributes is their simplicity. The most common features used are extracted by GLCM. In this project we will be analyzing MRI images for brain tumor using texture analysis. In previous work of the texture analysis the basic steps are feature extraction, feature selection and classification. The most common features used are extracted by GLCM [13]. These features have been widely used in analysis, classification, and interpretation of medical images. The features extracted are :

1. Angular Second Moment
2. Contrast
3. Correlation
4. Sum of Squares of variance
5. Inverse Difference Moment

6. Sum Average
7. Sum Entropy
8. Sum Variance
9. Entropy
10. Difference Entropy
11. Difference variance
12. Information measure of correlation 1
13. Information measure of correlation 2
14. Maximum correlation Coefficient

Texture feature which are extracted are very much essential for identifying and finding the object or ROI and shape based features which escribe the structure, volume and type of MRI.CT image. These features are used as an input for the classifier for feature selection algorithm. Once the features are extracted then for reduction two transformation will be applied for reduction of feature space. There may be number of features that will be extracted but out of them many are redundant and lead to inefficiency. So those redundant features must be removed as it leads to incompetence and loss of accuracy. Therefore, feature reduction techniques are used in order to reduce the number of features obtained and make sure that the efficiency and accuracy are not compromised with [21]. For feature reduction there are number of methods that can be used in order to eliminate the features. Some of the commonly used feature reduction techniques are Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA) [22], Genetic Algorithm (GE) [23], Ant Colony Optimization (ACO) [24], etc,. We will be proposing a new method which will use combination of PCA and ICA in order to reduce the feature set. After choosing a optimum and reduced feature set we will feed it into a classifier which will classify the tumor into two classes i.e., Malignant or Benign. In our system, we need only two classes to be searched for i.e., benign or malignant we will be using SVM classifier [26]because SVM is classifier used for supervised classification. Some of the advantages of using SVM is that it is linear classifier, it is robust and give results with high accuracy, it has simple boundary for prediction and it is computationally efficient. In the following chapters detailed study of the proposed method for brain tumor analysis.

1.2Problem Definition

- The limit of the malignancy in a picture is typically followed by hand which is tedious and hard to recognize and confine, recognition ends up infeasible with enormous arrangement of informational collections.
- While commonly managing therapeutic pictures where pre-medical procedure and post medical procedure choices are required to start and accelerating the recuperation procedure.

- Manual division of anomalous tissues can't be contrasted and current's rapid registering machines which empower us to outwardly watch the volume and area of undesirable tissues. Thus, there is a requirement for the programmed framework for the discovery of tumor.
- Therefore, we will model a system which will first preprocess the image using histogram equalization and image segmentation using PSO. It will enhance the tumor image and extract the level of tumor exist. After segmenting the image using PSO and extraction of GLCM features will be performed and PCA will be used to reduce the feature set and followed by ICA. This is how we will perform texture feature analysis which will help us to classify whether the tumor is malignant or benign.

CHAPTER 2

LITERATURE REVIEW

2.1 Review on Image Segmentation

In the ongoing occasions, the investigation of image processing has been a standout amongst the most significant errand. Out of which biomedical image processing is the most testing field of image processing and example acknowledgment. There has been a ton of headways found in field of biomedical image segmentation for recognition of tumor and injuries at the most beginning period. There are large number of methods which are utilized for image segmentation so as to isolate the region dependent on certain property like thresholding, region growing, Histogram equalization, Fuzzy C-implies etc.[26]

In the field of biomedical imaging there has been countless headways. New systems and technologies are being seen over a significant lot of time which gave number of image segmentation strategies. For this venture countless image segmentation systems are examined and in our undertaking we will utilize as of now utilized populace based methodology Particle Swarm Optimization for image segmentation. The most clear system for image division used is Thresholding of allocating nearer view and establishment of the image. Image thresholding is the best and accommodating in case of anomalous measures of separation. It will in general be Single measurement thresholding and Multilevel thresholding. The estimation has good position of fast blend, lower multifaceted nature and PSNR of computation increases rapidly [27]. The methodology is advantage when we have to find each practically identical area which are moreover disjoint. The bother of system is that it works for only two concealing images therefore not sensible as a matter of course. The methodology is defeated by various strategies on account of its low running time, less efficiency and to hinder over-division in thresholding the amount of segments should be more than number of levels. K-suggests gathering strategy is most clear bundle packing which is an unsupervised learning figuring. The packs are the get-together of pixels surrounded by specific features. Suman Tatiraju and Avi Mehta[28] in their paper on K-suggests described the estimation to parcel the images on the reason resemblance between data segments of a social occasion and contrast between the get-togethers. It has advantage when concealing image is there and number of segments are known. The hindrance of using this method is that an extraordinary arrangement memory is required for suitable working of this technique.

Histogram subordinate procedures are similarly used for image segmentation. In this system, histograms are plotted and a limit is picked to find various bits present in the image. A paper by Salem Shah Al-amrie [29] on Histogram subordinate technique given that an edge is found by learning the pixel's probabilities and variance of pixels.

In Image segmentation Fuzzy C-infers gathering is another procedure wherein each pixel is distributed C fuzzy qualities where each worth shows an investment of each pixel for individual bundle. In a paper by Yong Yang [30] on Fuzzy C-suggests clustering calculation for image segmentation in which count relies upon neighborhood and expected to be limited estimation. It has nature of division yet the running time is in like manner astoundingly high. The running time of this strategy increases exponentially with the amount of sections.The following table shows difference between the different segmentation approaches with their brief description and their advantages and disadvantages[31,32,33].

Segmentation Technique	Description	Advantages	Disadvantages
Thresholding	Based on histogram peaks & intensity values; find particular threshold value	Simplest technique; not much complexity Easier to impleament	Highly dependent on peaks; difficult to choose appropriate value threshold
Region Based Method	Based on dividing image into its homogenous regions	More immune to noise; useful when easier to define a similarity criteria	Computationally expensive; high memory requirement
Clustering Method	Based on division into homogenous clusters	Uses partial membership function therefore more useful for real problem	Determining membership function is not easy; Finding appropriate C-value is not simple

Otsu Algorithm	Automatic threshold selection region based segmentation	Global thresholding method depend only on gray value; better threshold selection method	As number of classes increases it takes too much time for multilevel threshold selection
Genetic Algorithm	Used to segment the image by using optimization function	Faster convergence for optimal solution; better results in terms of quality; less processing time	Appropriate value of parameters have to be given else may lead to slow convergence
Edge Based Method	Based on sharp intensity change; discontinuity detection	Significant for the images having better contrast between different points	Not suitable for highly smooth images or with to many edges

Table 1: Comparison of various Segmentation Techniques

2.1.1 Particle Swarm Optimization

Now we will propose a new method for image segmentation i.e., PSO which is given by James Kennedy and Russell Eberhart in 1995 and combine it with texture analysis and prove that how it can be used for tumor detection in brain. PSO is evolutionary technique for computation proposed by James Kennedy and Eberhart in 1995 whose basic idea was inspired by social behavior bird flocking, fish schooling and swarm theory. PSO is very similar to Genetic Algorithm in nature.

James Kennedy and Russell Eberahart [7]: The authors here developed a concept of optimization for non-linear and irregular functions using PSO. The advancement of different standard models is defined and implemented and one of the method is PSO. In this research paper, the model is described and its application is discussed. It includes non-linear optimization and neural network training network training is proposed here. The relationship between PSO and both artificial life and GE is described.

E. A. Zanaty [2] : In this paper the authors presented a blended approach which was based on clustering methods used to measure the gray matter(GM) and white matter tissue (WM) volumes from Magnetic Resonance Images (MRIs). Here they introduced the novel

algorithm proposed incorporates intensity and anatomic information for segmented MRI images into specific tissue classes, specially GM & WM. This initiates by dividing the picture into different regions using fuzzy clustering. These regions were givrn to seed region growing (SRG) method to isolate the suitable closed region. The seeds of SRG were selected as the output centers of fuzzy C-means clustering method. In order to, compare the performance of various outputs of this method "Jaccard similarity" coefficient is used to merge the similar neighbouring regions into one single segment. The algorithm proposed was applied to large number of applications which required gray&white segmentation in MRI/CT datasets. The implementational results had shown that their novel technique had produced accurate and stable results.

Ouarda et. Al. [34]: They are worked on the distinguishing different tissues and modalities of particular properties. They had majorly concentrated on segmenting the MR brain images using the algorithm particle swarm optimization and differential evolution. For segmentation they had used multilevel fuzzy thresholding methods, it make use of four threshold on the image to improve the efficiency of the segmentation. The evaluation parameters they had considered are Peak Signal to noise ratio. The results obtained by them are satisfactory both in terms of accuracy and robustness.

Liping Zheng, Quanke Pan , Guangyao Li , Jing Liang[35] : As Image segmentation is and important in image analysis and threshold segmentation is a basic and significant technique in gray-scale image division. Most extreme entropy technique is a typical threshold segmentation strategy. In their paper, the authors found a strategy just uses dark data. So as to sufficiently use spatial data of grayscale image, an improved 2D-entropy segmentation technique is proposed. This new strategy is called PSO-SDAIVE calculation. In this new strategy, the calculation of 2D entropy is improved. Something else, particle swarm optimization (PSO) calculation is utilized to unravel limit of improved entropy. Most extreme takes as the ideal segmentation of image threshold. In this paper, two head CT images are portioned in analysis. Contrast and other segmentation technique. Test results demonstrate this new technique can rapidly and precisely acquire segmentation threshold. Something else, this technique has solid enemy of clamor ability and spares calculation time.

Fahd M. A. Mohsen, Mohiy M. Hadhoud, Khalid Amin[36]: In this paper, authors proposed a new multilevel thresholding method which is based on PSO where the thresholding problem was treated as optimization problem and solved by using PSO principle. PSO is used to find best value of threshold that can give appropriate partition for target image according to fitness function. As PSO is an flexible optimization algorithm, where number of objective function can be chosen so therefore, a new fitness function was used for the same which gives better and faster result than thresholding as PSO will optimize threshold value.

2.2 Review on Texture Analysis and Classification

In biomedical imaging, texture analysis has been a great technique for detection and determination of tumor. From many years the scholars had been worked in the field of medical science for detecting the brain tumor detection and clustering it. There are many approaches that are given in order to work more efficiently and effectively in medical domain so that it can be more helpful in saving lives of those are suffering from such fatal diseases. Some of the proposed methodology are discussed below.

R.M. Haralick, et al [8]: Texture is one of the most important characteristics used in identifying objects or ROI in the image; whether the image be a photomicrograph, an aerial photograph, or a satellite image or some biomedical image. This paper relates some of the easily computable textural features based on graytone spatial dependencies, In this paper, different kinds of data is taken and texture features are computed which probably have wide range of applicability in image classification applications.

Using GLCM over medical image like MRI, various experiments were performed in past [37,38]. Those experiments were performed over brain MR images having tumor. The accuracy claimed was found in the range of 75%–89% using classifiers of neural network family.In [39] authors have used textures features as image retrieval. They have used shape and texture features. GLCM features are used here. For performance analysis precision and recall value are used.

Once texture features are extracted, feature reduction is next step that needs to be looked for as a large number leads to need of large memory. The performance of classifier highly depends on choice of the most relevant features selected from the list of variables. This can be achieved by applying different feature selection techniques on data set. So, in order to deal with it we have studied different methods of feature selection.

If feature selection techniques need to be broadly classified then they are classified in 3 main categories i.e., Filter method, Wrapper Method and Embedded Method. A brief description of these method is given below: [40]

1. Filter Method: These strategies select features dependent on separating criteria that are generally free of arrangement. A few strategies utilize basic connection coefficients like Fisher's discriminant measure. Others embrace common data or factual/statistical tests (t-test, F-test). Previously, filter methods dependent techniques assessed features in disengagement and did not think about connection between features. As of late, techniques have been given in order to choose features with minimum redundancy. The techniques proposed utilize a minimum redundancy-maximum relevance(MRMR) feature determination system. They supplement the maximum pertinence criteria alongside minimum redundancy criteria to pick extra characteristics that is not at all like officially recognized ones.

By doing this, MRMR extends the agent intensity of the feature set and improves their speculation properties.

2. Wrapper Method: Wrapper strategies uses a classifier as black-box in order to calculate the subsets of features and characteristics which are dependent on its prescient power. Wrapper techniques dependent on SVM have been broadly contemplated in AI people group. SVM-RFE (Support Vector Machine Recursive Feature Elimination), a wrapper strategy connected to malignancy research is called, utilizes a regressive feature disposal plan to recursively expel immaterial features from subsets of feature set. In each recursive advance, it positions the features dependent on the measure of decrease in the goal work. It at that point takes out the base positioned feature from the outcomes. Various variations additionally utilize the equivalent in backward feature elimination.

3. Embedded Method: Embedded methods which have been recently proposed and it has advantages of both the above methods. The classification algorithm takes advantage of its own offeature selection process and performs classification simultaneously. Hence, it proved as a better method of feature selection.

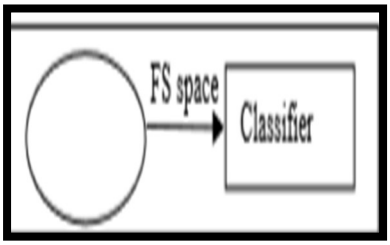

Fig 5(a): Filter Method

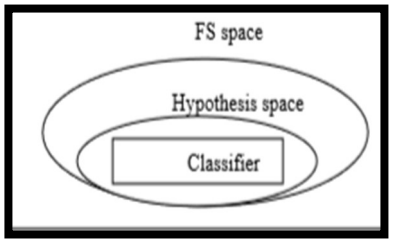

Fig 5(b) : Wrapper Method

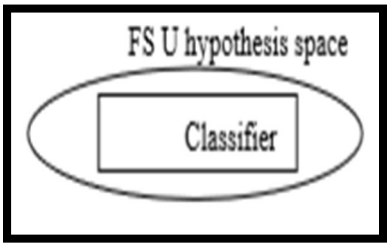

Fig 5(c): Embedded Method

The above given are broad categories of feature selection. Some of the commonly used method in the field of selection or reduction is Principal Component Analysis, Independent Component Analysis, Linear Discriminant Analysis, Genetic Algorithm, Ant Colony Optimization, etc. Following are the studies that has made in the field of feature selection and classification.

In [41], the authors worked on presenting a classification technique which is robust, for analyzing MR images. The technique consisted of extraction of GLCM features with selection using PCA+ LDA was implemented. The classifiers used here are Artificial NN and K-NN in order to classify MR images as normal abnormal. The proposed method led to effective and robust method which minimizes the computational complexity.

In [42], With regards to the appearance-based worldview for object recognition, it is by and large trusted that algorithms dependent on LDA (Linear Discriminant Analysis) are better than those dependent on PCA (Principal Components Analysis). In this correspondence we demonstrate this isn't generally the situation. We present our case first by utilizing instinctively conceivable contentions and afterward by indicating genuine outcomes on a face database. Our general decision is that when the training dataset is little, PCA can beat LDA, and furthermore that PCA is less sensitive to various training datasets.

In [43], the authors have suggested a novel method for feature selection i.e. PCA+LDA but with SVM classifier for classification. The classification accuracy is highly improved when features are selected using the two combined approaches.

In [44], authors had worked on separating the sources of the brain signals from the recordings. The processes involved are as follows, proved the assumptions for ICA applied for the EEG/MEG data, Collection of the averaged ERPs, analyzing the event-related EEG epochs collected, presented an case study for stimulus induced for alpha ringing, component stability. The functional magnetic resonance image has been applied to the FMRI images. In this the authors discussed about the limitations of the ICA method on fMRI images..

In [22,44], authors have utilized PCA, ICA and LDA with SVM however for various applications like face acknowledgment and EEG signal examination. Feature portrayal and classification are two key strides for face acknowledgment. They thought about three robotized strategies for face acknowledgment utilizing distinctive technique for feature extraction: PCA (Principle Component Analysis), LDA (Linear Discriminate Analysis), ICA (Independent Component Analysis) and SVM (Support Vector Machine) were utilized for classification. The examinations were performed on various applications and with the blend of strategies (PCA+ SVM),(ICA+SVM) and (LDA+SVM) demonstrated that (LDA+SVM) strategy had a high acknowledgment rate than the other two techniques for face acknowledgment and EEG signal investigation.

The papers referred to in [45,46,47] here gives a diagram of feature choice utilizing ICA. The papers gives us thought how features can be chosen utilizing ICA and furthermore gives us thought what ICA is. ICA is investigation that is utilized to isolate the blended sign. The papers are giving the choice criteria for surface features. In proposed strategy, in view of studies we will utilize kurtosis [48] for end of Kurtosis.

In fact, the vast majority of the division calculations which are suggested so far so far depends on classification and clustering methods This is for the most part owed to the way that with these techniques, multi-modular dataset can be dealt with effectively in light of the fact that they can work on any picked feature vector. By and large, the features on which these calculations work incorporate voxel-wise powers and much of the time additionally neighborhood surfaces. The general thought is to choose for each and every voxel

independently to which class it has a place dependent on its feature vector. Classification requires preparing information to get familiar with a classification model, in view of which new examples can be marked. Clustering, then again, which works in an unsupervised way and gatherings information dependent on certain similitude criteria. We will utilize classification. During my examination, I ran over numerous classifiers like SVM, A-NN, K-NN, and so on,. As necessity of our undertaking is just isolating information into two classes i.e., threatening and benevolent. So, for that in out venture we will utilize SVM classifier.

In the paper given [50], authors described brain tumor as perilous and deadly to human life thus for discovery of tumor distinctive classification methods have been proposed in order to detect MRI images. In their research, brain tumor was detected from MRI images with the help of cream system has been finished. This crossbreed method consolidates discrete wavelet transform (DWT) to be used for feature extraction, once the feature are taken the reduction is performed and then classification is done using support vector machine (SVM) for brain tumor classification. The proposed novel method is implemented using MATLAB2015a stage. Parameters used for separating the images are given as: entropy, smoothness, root mean square error (RMS), kurtosis. The reenactment investigation approach results demonstrates that half and half methodology offers better execution by improving exactness and limiting the RMS error in correlation with the best in class strategies in the comparable setting.

In [51], This examination paper proposes an insightful characterization procedure to perceive benign and malignant tumor in brain MRI image. Medicinal images like ECG, MRI and CT-examine images are significant approach to analyze and diagnose the lesions or disease and malady of person proficiently. The ongoing examination done manually by doctors of tumor dependent on visual review by radiologist/doctor is the ordinary strategy, which may prompt wrong arrangement when an enormous techniques for which MRIs are to be investigated. To stay away from the human blunder, a robotized wise grouping framework is suggested which fulfills the requirement for order of image. One of the real reasons for death among individuals is Brain tumor. The odds of survival can be expanded if the tumor is identified effectively at its beginning time. Attractive reverberation imaging (MRI) procedure is utilized for the investigation of the human mind. In this examination work, order systems dependent on Support Vector Machines (SVM) are suggested and connected to mind image characterization. In this paper, it includes extraction from MRI Images will be done by dark scale, symmetrical and surface highlights. The principle target of this paper is to give a superb result (for example higher precision rate and decrease mistake rate) of MRI brain malignancy characterization utilizing SVM.

CHAPTER 3

PROPOSED METHOD & TECHNOLOGY

3.1 Proposed Method

In this project we will be analyzing MRI images for brain tumor using texture analysis. In previous workdone in the field oftumor or lesion analysis, image segmentation and texture analysis are seen as the general techniques for tumor analysis. So, an overview of basic methodology of proposed method is given by the following block diagram.

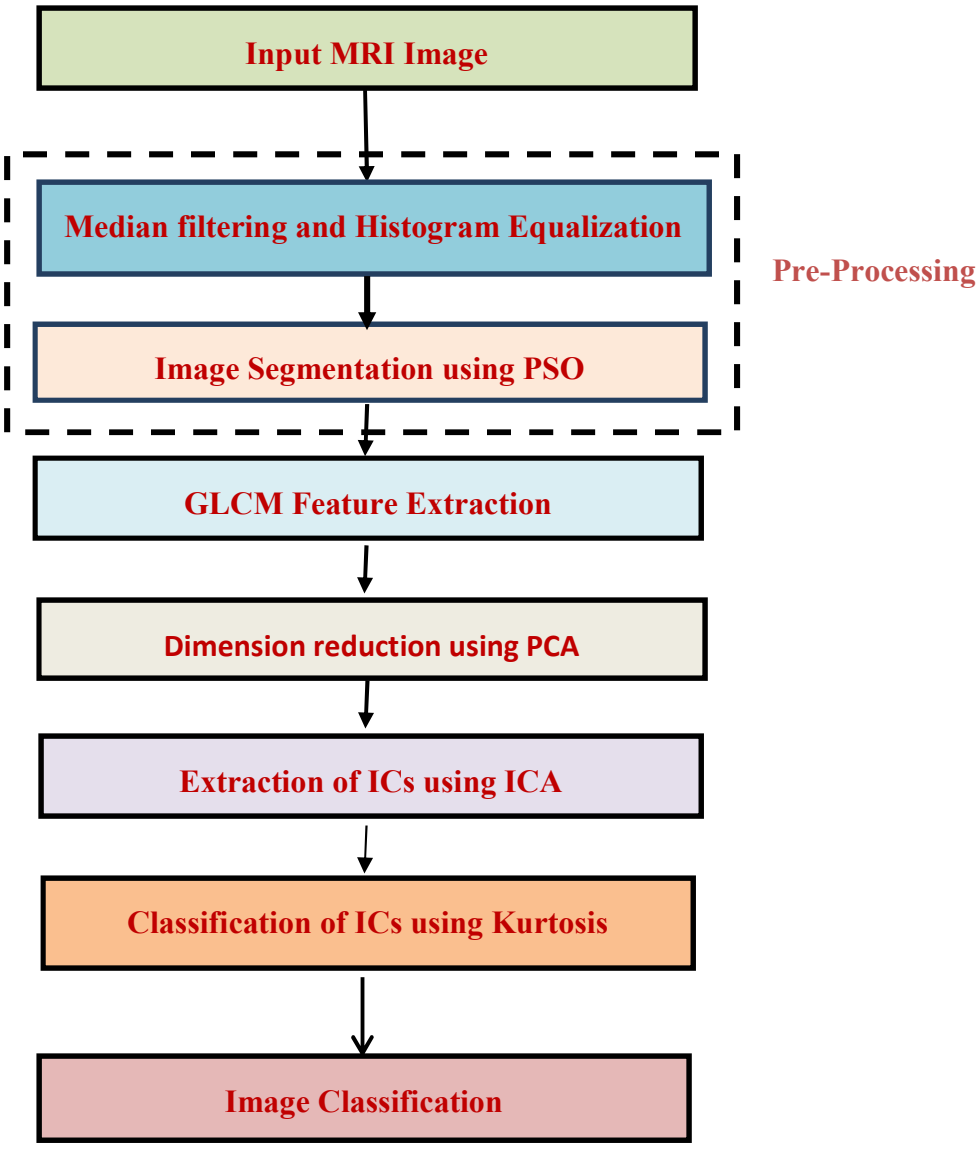

Fig 6: Overview of Proposed Method

The above flow diagram shows that our proposed method takes the input as MRI image and then texture analysis is performed over the segmented image. The region of importance is taken out and on them RGB to grayscale MATLAB operation is performed. Then GLCM features are extracted. The detail of the steps of our proposed method is discussed further in section and the overview of the process is as follows:

1. Pre-Processing: i) Median filtering and Histogram Equalization
   ii) Image Segmentation using PSO
2. Texture Feature Extraction
3. Feature and Dimension Reduction using PCA and ICA
4. Image Classification

The above given steps are an overview in order to work on MRI images for medical analysis. The steps will be explained further. The Block Diagram given below represents how our method works in order to detect tumor from the MR images and it is self-explanatory.

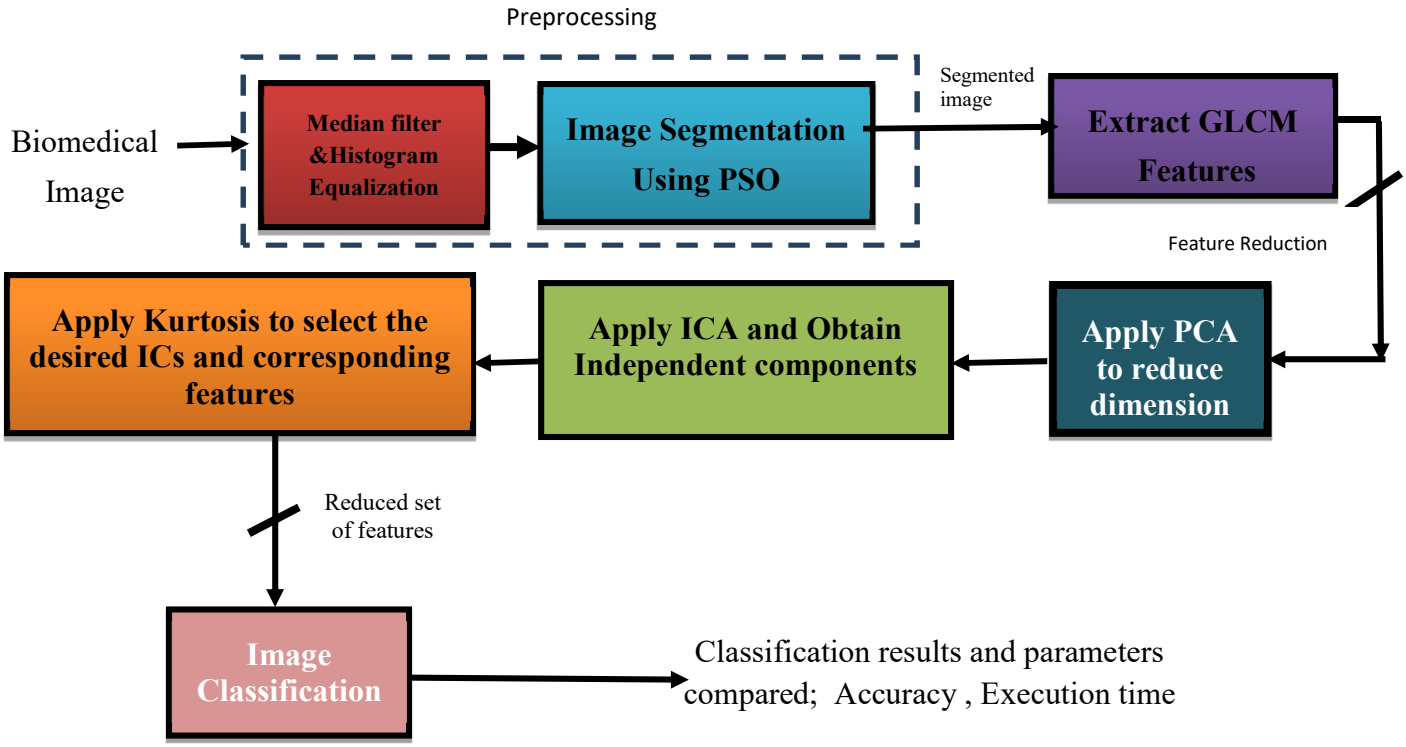

Fig.7: Block Diagram of Proposed method

The novel approach that we have proposed is able to detect the brain tumor by first doing the preprocessing for the MRI image. MRI image often contain artifacts in the image background. These can be a roadblock for further processing and segmentation because

they represent separate components that are also recognized as such by the connected component algorithm, even though they are not part of the tissue that needs to be examined so they leads to inefficient detection which can prove fatal for someone's life [51]. These artifacts are removed from the image background in a first preprocessing step by performing the median filtering operation on the MRI image. After removing noise, we will do histogram equalization to enhance the image quality by providing the values to every pixels ranging from 0 to 255[52]. Once preprocessing, is done we will apply segmentation to separate the pixels of same kind so that further analysis can be done. There are huge of methods that were used for segmentation in medical analysis for eg., thresholding, region growing, K-means clustering, FCM etc., but all these methods used have their own disadvantages which will be discussed later. Therefore, I came up with using new method proposed by Eberhart and Kennedy in 1995 i.e., Particle Swarm Optimization [7] which is a population based method. The above flow diagram shows that our proposed method takes the MR image, removes noise, segments it and then perform texture analysis to classify into two classes.

First we will be applying PCA for dimensionality reduction [53]. The PCA will give reduced set of feature vector space. As we reduces the feature set using PCA Then ICA will be applied on the reduced feature space [44,45]. Due to ICA transformation set of independent components and a mixing matrix will be obtained [54].,. The following diagram gives overview of getting IC using algorithm.

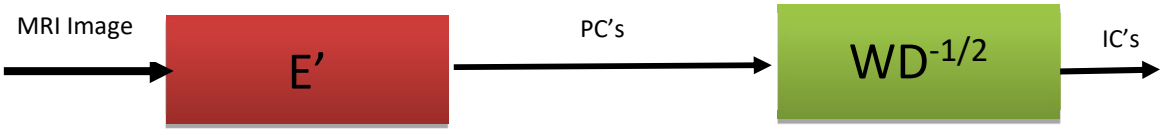

Fig 8: A block diagram to obtain ICs

For ICA feature vector , the equations and symbols are given as :

$$x(t)=Av(t)=D\text{-}1/2E'y(t) \qquad (3)$$

where A is d x k ($d \leq k$) whitening matrix that is given by eigenvalues, D and a matrix of eigenvectors, E . Here, y(t) is composed of d statistically independent signal c, $c(t)=\{c_1(t),c_2(t),\ldots\ldots\ldots c_d(t)\}'$. Thus,linear transformation from x(t) to s(t) is as follows : c(t)=Wx(t) where W is separation matrix given as {w1,w2……}. Then to reduce the set of components obtained for each corresponding feature we will find kurtosis for each component and then discard the components with low values of kurtosis[48,55]. This is how feature section will be done for texture features taken out for MRI images. Once the reduced feature space is obtained we will be providing the reduced set to classifier like SVM[49 ,51]

and will calculate and compare certain measures like accuracy, efficiency, sensitivity, time complexity etc

3.1.1 Datasets

Pre and post-operative MR, images are taken from patients affected with brain tumor at Montreal Neurological Institute in 2010. Every patient was asked to sign the specific consent form for distribution of their images on internet. (NEU-09–010). All the patients in Institute had gone under had a pre-operative and a post-operative T1-weighted MR with gadolinium and multiple B-mode images pre- and post-resection. From their images we found corresponding features were manually picked in some pairs of image for validation and testing. All bio-images were in MINC format, the format of the file used at our institute for image processing and analysis.

3.1.2 Pre-Processing

In image analysis. image enhancement and pre-processing play a vital role for analyzing MRI/CT/ultrasound bio-images. Since, these images have less contrast and speckle noise therefore, pre-processing like image intensity adjustment, noise removal, segmentation etc.MR images often contain artifacts and noises in the image background. These can be a barrier for further processing and segmentation because they represent as a component which will get examined even if it is not required. Therefore, these artifacts are removed from the image background in a first preprocessing step. The preprocessing steps are based histogram equalization for image enhancement and applying median filter on MRI image as it helps to reduce and eliminate salt and pepper noise. The enhanced image provides useful information which improves the quality of image and is beneficial in post-processing, especially in segmentation.[56]. Given below is the detail of preprocessing step we chose:

Median Filter: Noise in MR images can occur due to large number of reasons/causes and sources which may be internal or external like machinery effects, environmental effects, transmission system, etc. Therefore, noise and artifacts removal method is an important step that needs to be done which smoothens the image and removes artifacts. The process in which noise is removed and image quality is restored is called as image restoration. In our project, we will be using “median filter” in order to remove the noise and artifacts. The MRI image may be low in quality or it may has bright or dark pixels all inside the image which is commonly known as “Salt and Pepper Noise”. This noise generally have bright pixels in dark portion and dark pixels happens to be present in bright portions. This noise will generally have bright pixels in dark portion and dark pixels in bright portion of the image. Black and white spots exists in whole image which represents artifacts. Sharp and unexpected changes may occur and image is considered to be a noisy and prone to artifacts. It causes errors, A2D converter errors, dead pixels, etc. in the image. Salt and pepper noise

is very common to occur and can be removed by the Median filter. We could have used gaussian filter to remove gaussian noise but sometimes it blurs and over-smoothens the image.[56]

Histogram Equalization (HE): Histogram Equalization is technique which will process the images in order to modify and alter the contrast of an image by regulating the the intensity distribution of histogram [58].The goal of this method is to provide a linear and regular trend to the cumulative probability function associated to the image[52,57]. It is used as enhancement techniques which improves quality of image and make them less blurred and easy to analyze. HE is based on global techniques which works on intensity values. These techniques are simple and easy to apply. Once the image is processed and enhanced, we will perform segmentation. These operations are useful in removing irrelevant artifacts from images.

3.1.2.1 Image Segmentation Using PSO

Particle swarm optimization (PSO) is modern technique that is currently being used as an latest approach for wide range of applications. It is an population based evolutionary technique which is used for computation based on colony behavior and proved to be a better searching algorithm. In image processing and segmentation, a low level vision objectives are there and applications like object recognition, medical imaging, aeronautical sciences, data mining etc. can be easily solved using PSO. PSO is itself a very efficient and effective technique and when combined with other calculative and computational intelligence technique results in a truly affected approach. In this project, PSO will be combined with texture analysis. The novel technique of PSO is developed and given by Kennedy and Eberhart in 1995[7]. The authors used this method due to its simplicity, optimization accuracy and fast convergence. In present scenario, PSO based methods and techniques are currently and widely used as an efficient image analysis and segmentation application [59]. PSO is an heuristic or trial-and-error global optimization method which based on swarm intelligence. The notion and idea of PSO as segmentation method which originated from behavior and nature of birds or particles and social interaction between particles. The main abstraction of PSO is the way particles/birds search for their food and gets scattered or move here and there to find the food. The birds will end their search once they find the food. The basic algorithm and process consists of N swarm particles and parameters, principle and algorithm is discussed below. The swarm particle which changes its position according to three principles [59].

- Store the value of inertia
- Store the value of position and update the condition with respect to the particle's optimal position

- Find the condition with respect to the most optimal position of swarm

$$v_i^- = wv_1^- + c_1R_1\left(p_{i,best}^- - p_i^-\right) + c_2R_2(g_{i,best}^- - p_i^-) \quad (4)$$

$$p_i^- = p_i^- + v_i^- \quad (5)$$

In these two equations, v_i^- *and* p_i^- are velocity and position of particle i respectively. $p_{i,best}^-$ *and* $g_{i,best}^-$ are defined as position with fitness value found so far by particle i and entire population respectively; w is the control parameter or inertia which control convergence behavior of PSO. The random function is given by R1 and R2, whose range is between [0,1]. c_1 and c_2 controls "how far a particle move in single iteration". Once velocity is updated using equation (4), we will then update position using equation(5). Once updated, the value should be checked and limited allowed range. The memory update will be done as follows :

$$p_{i,best}^- = p_1^- \; if \; f(p_i^-) > f(p_{i,best}^-) \quad (6)$$

$$g_{i,best}^- = g_1^- \; if \; f(g_i^-) > f(g_{i,best}^-) \quad (7)$$

A number of iterations will be made and will get converged after getting the best value and it will report (g_i^-) *and* $f(g_{i,best}^-)$ as its solution. The following table describes different parameters used by PSO [59].

Parameter	Description
Particle	Candidate's solution to the problem
Velocity	Rate at which position changes
Fitness	the best solution achieved
$\mathbf{p_{best}}$	Local best value of particle
$\mathbf{g_{best}}$	Global best value

Table 2: Parameter description for PSO

3.1.3 MRI Texture Feature Analysis

Features are defined as set of properties and characteristics which explains the whole picture in term of those features. In bio-medical image processing, feature extraction is seen as an important step in order to deal with image and also time and reduces complexity that may exist due to manual analysis of image. In order to get important traits and parameters of images image analysis is done. The features extracted will provides us with different traits and qualities such as shape, texture etc. and these features are reserved and will be later processed according to application required. These features contains the texture information such as homogeneity, gray tone linear dependencies, contrast, number which is important to characterize and find the nature of boundaries present and the complexity of image. In biomedical images, there can be number of features that can be extracted. For detecting brain tumor in brain and analysis, the features that can be extracted are shape, texture, etc [13,14] ,. In our project we will be using Texture feature for analysis. There are number of ways to extract Texture features like Gabor filter[17], GLCM features[8] etc. We will be using GLCM features for analysis. Following sections will give detailed study of the textures features used.

3.1.3.1 Texture Feature Extraction

Texture features are defined as one of the prime attributes that could be used for recognizing and distinguishing the region of interests. A large number of texture features can be computed based on gray-tone spatial dependencies. Textural feature space consists of information about distribution with different tonal variations within the band. The idea of tonal based feature analysis is very much dependent on based shades of gray resolution which varies within the cells of MRI images while texture is mainly bothered with gray tonal statistical distribution. Texture & tone are similar to each other and generally both are visible in the in image and tone are not much different and they bear relationship with each other. Contrast, texture and tone are always present in an image. There can be number of texture, it can be fine, smooth, regular, irregular, coarse etc. It is a characteristic of all surfaces. It can be extremely used for precise and accurate analysis of machines and systems.. For discrimination purposes, textural features of an image appear to carry proficient and very information and therefore, it is very much crucial to construct a good texture feature set that can be further used for classification For given texture features we calculate a set of probability distribution matrix of gray tone intensity for a given particular block and will recommend a set that will be extracted and fed to classifier.

Need of Texture Features in Medical Image Analysis: The dependency on machine learning in medical domain has increased a lot. Earlier, many researches have been published for representing digital images using machine learning algorithms by employing statistical features. Extracted features should always be strong enough to represent an image in digital machine systems used in machine learning. These extracted features must include

the properties of an image using which it is identified in digital databases image using which it is identified in digital databases. Texture is one such feature that is used for object description. Texture helps in identification of the surface of objects presented in images. Texture feature analysis is primely used to detect, monitor and analyze the tumor/lesions so that treatment can be planned for tumors present in humans and helps in recovery from particular disease. Texture is defined as a measure i.e., defined for intensity difference for a surface and quantifying the characteristics such as smoothness, regularity, granularity, coarseness[51]. In image analysis, robotics & computer vision texture is used as an important region descriptor. In order to analyze and describe the image there are number of methods which are applied and used. For texture feature extraction within medical or any image we can use methods like run length coding, fractal dimension, Gabor transform [18] etc. and co-occurrence matrices with two dimensions can be used. After the study of all the above techniques we in our project extracted texture features using GLCM method extract to extract the features which will be used for classification. The prime objective of selecting texture feature is that it will help to classify and characterize the different intensity region within brain images and helps to find the tumor and therefore, we expect texture feature set will have enough information and differentiation power to distinguish among different `types of regions. Generally, we can secure the texture information of different areas of brains using two-degree statistical models: 1) The gray level co-occurrence matrix and 2) Gray level run length statistics. For entire representation of machine and set of images a set of texture descriptors will be calculated. Texture features are considered for MR images because using texture for tumor detection is much easier as compared to other features like shape. When the texture of normal MRI images changes then the radiologist can easily compare it and judge the presence of tumor. Therefore, texture features are beneficial and useful for detection of MRI tumors.

The features that we extracted using different approaches like GLCM provides valuable information about MR images. Here, we will use “Gray Level Co-Occurrence Matrix” which is a statistical approach that will help the engineers to examine the type of texture which is accountable to the spatial relationship of different pixels. GLCM represents the probability of gray levels or intensity levels. GLCM is a method i.e., useful in determining the co-occurrence matrix of image. It helps to determine that how the relation occurs between two pixels at a finite distance and at a specific level. The addition of number of times the pixel with a value lets say “I1”exists in a specified spatial relationship with another pixel, let us say I2 in the given input(MRI) image. In the process of finding features through GLCM matrix, there are huge and same number of gray levels (G) in image, as the numbers of rows and columns in the corresponding matrix. The texture features extracted are the features like contrast entropy, energy etc.

GLCM Feature Extraction: In order to perform texture analysis on images, texture features are calculated from different statistical distribution and approaches of observed

cases of intensities at different specific positions which relative to each other in the image. According to the number of intensity points (pixels) in each combination, different statistical parameters are calculated which can be of any order i.e., first, second or any higher order. The Gray Level Co-occurrence Matrix (GLCM) technique is the way by which we can find and extract 2^{nd} order statistical texture features. This method is now used in vast number of applications. Textures with higher orders moments are only used in order to find the relationships among three or more pixels. Higher order statistics are only conceptually computed but when it comes to usage then the complexity related to them comes into picture and interpretation of those features become unrealizable. So we can say that, GLCM matrix is the one where the number of rows and columns are equal to the total number of gray intensity levels present in the image.

Textures based features will be obtained using GLCM. In our project, we are primely focused in finding the statistical and numerical approach. Therefore, after finding we will work and make use of only the most suitable Harlick's features that are stated below. The importance of using texture features is that they are simple and less complex to compute. The most common GLCM features that are used widely in analysis, classification, and interpretation of medical images. The features extracted are :

1) Angular Second Moment
2) Contrast
3) Correlation
4) Sum of Squares ; variance
5) Inverse Difference Moment
6) Sum Average
7) Sum Entropy
8) Sum Variance
9) Entropy
10) Difference Entropy
11) Difference variance
12) Information measure of correlation
13) Information measure of correlation 2
14) Maximum correlation Coefficient

Texture features are most suitable for finding and identifying the region of interest i.e., tumor affected region. Since other features like shape features like area, circularity, volume etc which describe the structure of lesions or tumor in MRI/CT images. The MATLAB commands used for GLCM feature extraction. The following are the MATLAB command to extract GLCM features from MRI image.

i. `i1 = imread ('mri.jpg');`
ii. `gray1 = rgb2gray (i1);`

iii. s1 = imresize (gray1, [128 128]);
iv. glcm1 = graycomatrix (s1);

For 128*128 size a GLCM of 8x8 will be formed . An example for GLCM is given below. GLCM matrix is obtained we find GLCM features using graycoprops().

The corresponding GLCM matrix obtained from MATLAB code is shown as snippet

```
>>i=imread('15.jpg');

>>w1= rgb2gray(i);

>>r1= graygomatrix(ei);

>> r1

4762    192     85     51     31     28

178     249     195    67     563    21

104     198     1342   563    74     19

51      69      605    2503   557    47

31      26      65     571    1255   232

>>stats =graycoprope(r1);

>>stats

Stats=

Contrast :      1.0968

Correlation :   0.5597

Energy :        0.1299

Homogeneity:    0.101
```

3.1.3.2 Feature Selection/ Reduction :

In the above section we studied about number of methods that can be used for feature reduction. When features are extracted via number of features extraction techniques then the features extracted may be redundant in nature and they may lead to some negative effects and can deteriorates the overall performance of pattern classification and recognition systems. Generally, there are too many features which are extracted which actually reduces

the accuracy and efficiency of the system as they may be redundant or non-informative. So, Feature reduction and selection is defined as the method of reducing or eliminating the redundant and non-required features from the group of features and keeping the group of only relevant features [44]. The following diagram shows what does the feature selection algorithm does.

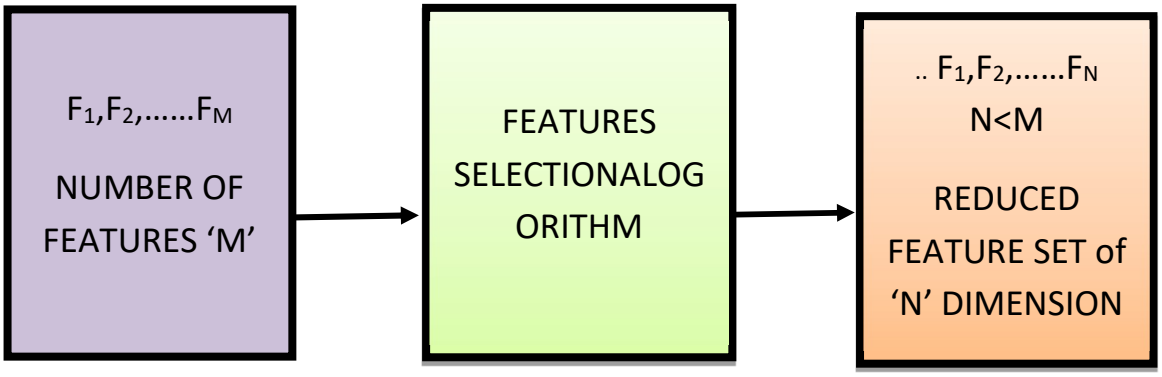

Fig.9: Feature selection Algorithm

There are a lot of methods that are used for obtaining such subsets. Some of the commonly used feature selection approaches are Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis(ICA), Ant Colony Optimization (ACO), Genetic Algorithm (GE) etc.[28]. As storing and using all the features will not only consume extra memory and but also it will reduce the efficiency and accuracy of the overall system. There are number of methods that have been suggested for feature reduction. In LR survey, we gave different methods that are used in order to be used for feature reduction. We studied about comparison of PCA, ICA, LDA[29] as feature selection techniques, In our project, we proposed a new and novel technique for reduction of feature set which combined two algorithms PCA and ICA and we will see that how our method increased accuracy when the reduced feature is given to classifier. In the given sections we will see how our method is better as compared other similar methods of feature reduction in terms of performance analysis parameter.

Principal Component Analysis(PCA): Once GLCM features are extracted, the feature vector will be given to PCA for reduction. PCA is a mathematical tool used for reduction of feature set based on the eigen values [53].

- **PCA** is applied on feature set to extract spectral features.
- PCA maps the spatial information of GLCM to vector space where information is represented by Eigen values and Eigen vectors.

- These vectors are considered as features which represent the image information. The size and dimension of feature set is based on the number of Eigenvector which are used to represent information. The dependency of Eigen-vectors is on the size of the matrix which is mapped from spatial domain to spectral domain.

- PCs are chosen according to their eigen value or their maximum variance

- The initial components that are related to high eigen values are chosen and rest are ignored from the feature set.

To perform the above stated issue the PCA is used which is going to reduce the size and dimensionality of the data base the steps followed are as follows:

In order to calculate PCA, the below algorithm is used. Let us take feature dataset which consists of m+1 dimensions and our new dataset becomes m dimensional.

1. Calculate the average or 2^{nd} order moment for every dimensional feature for complete dataset
2. Next calculate covariance matrix of complete dataset
3. Calculate eigenvectors & their corresponding eigenvalues
4. Arrange the eigenvectors in order of decrementing eigenvalues & select N eigenvectors with large eigenvalue and compute m x n dimensional marix W
5. Use this m x n eigenvector matrix to convert the samples onto the new reduced feature subspace.

By using the above steps instead going for more features the dominant features are selected by performing inverse of the matrix operation on image. Once the PCA is performed the dimension of the dataset will be reduced. Therefore, in this way PCA analysis will be applied so that we can reduce the dimensions of feature set that we obtained using the above method. The reduced from PCA will be given to ICA for reduction analysis.

Independent component Analysis(ICA) : ICA is defined as method that will extract statistically independent components from the set of measured or observed signals [47,54]. This technique is used for BSS problem and widely used for signal separation..

- ICA is a method that is used for segregating and isolating a multivariate signal in sub-components, where it is assumed that there is existence of mutual statistical independence between different components of the non-Gaussian source signals. ICA is defined as instance of BSS.

- In ICA Gaussian variables are removed and it is helpful in removing gaussian noise, because their joint density shows a completely symmetric density.

- Kurtosis value for Gaussian is zero

In order to implement ICA we will be using FASTICA [60,61] algorithm in our project. The steps for performing fastICA is given as below.

Before we use or apply any of the standard ICA algorithm it is better to operate the data using some pre-processing so that it can be simplified and complexity is reduced for the given task or problem. Those steps are :

1. Centring: we will simply subtract mean from the values of feature. This will make the correlated input signals (x) changed to uncorrelated data. It removes DC offset from observations.
2. Whitening: It removes linear dependencies and normalize projection variance. .ICA finds the independent components and PCA find the uncorrelated components; Centering is similar to PCA ; gives uncorrelated components and whitening give statistical data.
3. Other pre-processing steps will be applied depending on the application required (for ex.: dimension reduction)

In our proposed method, perform feature reduction/selection utilizing PCA pursued by ICA. PCA will choose the features dependent on eigen values. The one with bigger eigen values will be held and with the littler one will be considered as undesirable. When features with higher eigen values are picked will be given to FastICA calculation for ICA implementation. ICA will give us Independent segments of features which will be additionally wiped out utilizing Kurtosis.

The following table tabulates the differences between ICA and PCA and gives us a image why there is requirement of developing a model with PCA followed by ICA.

ICA	PCA
Divide into independent components	**Reduces the Dimension**
Faster to compute and best estimation of independence	**Used only for feature space/dimension for ICA**
Statistically Independent Data	**Statistically uncorrelated Data**
ICA is superior	**PCA act as pre-processing for ICA**
Superior for false color composition in a noisy image	**Poor performance in case of noisy image**
Used for Non-Gaussian Distribution	**For Gaussian Distribution**

Table 3: Differences between PCA and ICA

Using Fast ICA we will obtain Independent components corresponding to GLCM features. Those features are then be used for selection. reduced set of feature vector space feature space. Due to ICA transformation set of independent components and a mixing matrix will be obtained. Then to reduce the set of components obtained for each corresponding feature we will find kurtosis for each component and then discard the components with low values of kurtosis. This is how feature section will be done for texture features taken out for MRI images.

Assuming that there are linear mixtures $x_i \in R^d$, i = 1, ..., N, of independent source vectors $s_i \in R\ d$, i = 1, ..., m, the noiseless model becomes

$$x_1 = a_{11}\ s_1 + a_{12}\ s_2 + \ldots + a_{1m}\ s_m$$

.

.

$$X_n = a_{n1}\ s_1 + a_{n2}\ s_2 + \ldots + a_{nm}\ s_m$$

or in matrix notation

$$X = AS \qquad (8)$$

ICA aims to find matrices W and S from X, where the rows of S are as independent as possible, such that

$$S = W X \qquad (9)$$

Once ICs are obtained, we will select the desired independent components via a selection technique discussed below. And once desired ICs are retained and reserved as required or favorable features we will reconstruct the feature set and provide to the set classifiers and mark the accuracy.

3.5.3 Applying Kurtosis

Once we apply ICA to our reduced feature set so that the accuracy that was hampered using PCA can be compensated, we will obtain a matrix of Independent components. In order to remove components which are less required we will make use of a statistical parameter i.e., Kurtosis [43]. Kurtosis is defined 4^{th} order moment of statistical measure We will apply Kurtosis to the set of IC's we have obtained and find out the Kurtosis value for each IC's. The equation 10 gives the formula for Kurtosis:

$$kurtosis = \frac{\sum_{i=1}^{M}(Y_i - Y^{-})^4 / M}{s^4} - 3 \qquad (10)$$

The above condition is for finding the estimation of kurtosis where Y^{-} is the effective expectation of "2^{nd} order moment or mean", s is the "standard deviation", and N is defined as quantity of information focuses. Note that in figuring the kurtosis, the standard deviation is processed utilizing N in the denominator as opposed to N – 1. The fundamental motivation to discover the kurtosis it will quantify the tailedness/peakedness of the probability distribution. The feature choice will happen dependent on the level of kurtosis esteem. The lesser degree will be disposed of and the higher esteemed one are picked for the significant feature segregation between the ordinary and sick brain.

As Kurtosis worth can be both negative or positive so considering the outright vales of Kurtosis we will rank the IC features arranged in order of their independence. The ICs with less estimation of Kurtosis than certain limit (we considered edge as normal of total values of kurtosis) will be rejected and ICs with 0 estimation of kurtosis won't be considered as they speak to gaussian and along these lines this strategy will likewise do Gaussian noise removal. The rest of the ICs will be saved and utilized for further characterization. The features comparing to the safeguarded ICs will be encouraged to classifier and subsequently utilized for classification[55].

3.5.4 Classification

Classification is defined as the method of predicting the class of given points and it is predictive modelling where a mapping function(f) is approximated from input variables(x) to discrete output variables(Y). Once relevant feature set is obtained we will train the classifier using them. The main focus of classifier is to arrange the data/feature in different classes. The number of classes can be two or more than two. Number of different statistical, optimization and probabilistic techniques can be implemented as classification method such as regression, artificial neural networks(A-NN), K-Nearest neighbor(K-NN), Decision tress etc.[62].

SVM : Support vector machine was at first produced for example characterization or acknowledgment task. SVM is utilized as characterization calculation and give nearly high exactness when contrasted with other arrangement calculations [63]. In pattern recognition we divide data into classes which are the result of classification. SVM is also seen as twofold or binary or two degree classifier where the information tests have precisely 2 classes, similar to our required information has unusual and ordinary lung image. SVM classifier depends on the different class of hyperplanes. The ideal hyperplane is seen as one with the maximal edge of detachment between the two classes (typical and irregular) i.e., Benign or malignant

$$(w.\ x_j + b) \geq +1 \text{ for } y_j=+1 \text{ where } j=1,2,3,\ldots m \quad (10)$$

$$(w.\ x_j + b) \leq -1 \text{ for } y_j=-1 \text{ where } j=1,2,3,\ldots m \quad (11)$$

The conditions above can be modified as $(w.\ x_j + b) \leq 1$ where j=1,2,3,…m

SVM is a classifier that is utilized for arrangement of both straight and non-direct information. SVM has a favorable position of limiting the characterization mistake and boosting the geometric edge. For non-linear information, it ports the information vector into a higher dimensional space where a maximal hyperplane is fabricated. Change of info vector into higher dimensional space, it looks for non-straight ideal seeking hyperplane with the assistance of help vectors and edges. SVM handles this by utilizing a portion work (nonlinear) to outline information into an alternate space where a linear (direct) can't be utilized to do the detachment. It implies a nonlinear capacity is found by direct classifying system in a high-dimensional component space while the limit of the framework is constrained by a factor that does not depend on the extent or dimensionality of the space. This is called as piece trap which implies bit capacity change the information into a higher dimensional element space so that it can become conceivable to work straight detachment. On the off chance that the quantity of features is excessively enormous, at that point it may not require porting the information into higher dimension space. That is, nonlinear mapping will not improve the presentation then the direct piece will be the great decision of mapping.

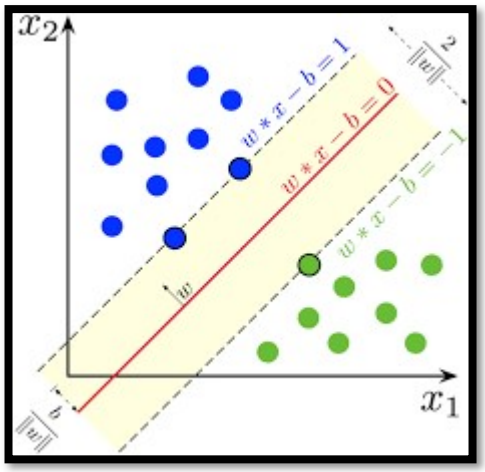

Fig 10: SVM hyperplane Illustration

The fig 10 demonstrates that the SVM has been structured three hyperplanes with the three distinct conditions, the blue shading shows one class and the green shows another class. The blue and green balls on the lines are called as help vectors. On the off chance that the preparation information is directly detachable, we can choose two parallel hyperplanes that different the two classes of information, with the goal that the separation between them is as huge as could reasonably be expected. The area limited by these two hyperplanes is known as the "edge", and the most extreme edge hyperplane is the hyperplane that untruths somewhere between them. With a standardized or institutionalized dataset, these hyperplanes can be depicted by the conditions. The equations for generating the hyperplane lines are as follows:

$$w^{-}.x^{-} - b = 1 \qquad (12)$$

The above equation is used to generate the boundary line for making decision. Any data which comes on this line or lesser belongs to one class and it is with the label 1. (In figure line nearer to blue)

The boundary line for differentiating the another class the equation is given below

$$w^{-}.x^{-} - b = -1 \qquad (13)$$

The labels can be -1/1 or 1/0 these labels are used to make the difference between two features in the dataset. So, this equation generates the below line which is nearer to green color in the Figure 10. The question is to select the most optimum line which can successfully make a boundary between two classes. It is given by the following equation :

$$\mathrm{w} * \mathrm{x} - \mathrm{b} = 0 \qquad (14)$$

This is the optimum line which is significantly distant from both the class dataset.

For our experiment instead of blue and green balls we are placing the reduced feature set generated from ICA. The SVM kernel we will be using is only two classes to differentiate.

The main classifier that we considered for our machine is SVM. But in order to prove that our system works irrespective of classifier so we compared over results using A-NN and K-NN.

Training and Testing :Similar to all machine learning approaches classification requires two important steps i.e., training and testing. Training of a classifier means providing the familiar data to classifier along with previously known decision values so that further it can be used further for testing and a finite training set is formed which will help to make a decision for any new or test data that to which class it belongs. The very common practice that is seen for feeding data for training and testing part is that in classification is that around 1/3rd is used for testing purpose and 2/3rd of the total dataset is used for training. From the training set, the classifier gets its insight to order obscure information and intelligence. In testing stage, obscure information is given and arrangement is performed and implemented utilizing prepared classifier. For abnormal or malignant case it is 1 and for typical stage or benign case is 0.

Performance Measures: The performance of the different methods used for feature selection can be tested and checked by using different classifiers like SVM,KNN etc. To evaluate the performance of the classifier there are several statistical measurement parameters named as Precision, Recall, Accuracy and F- measure. The details of parameters are given below:

Precision: The proportion of entire set of features in all the images that are correctly classified over total number of images that are to be classified for a class.

$$Precision = \frac{True\ Positive}{True\ Positive + False\ Psitive}$$

Recall(Sensitivity):The division of significant instances i.e., proportion of absolute number of correctly classified images and anticipated genuine outcomes

$$Recall = \frac{True\ Positive}{True\ Positive + False\ Negative}$$

Accuracy: It is the proportion of number of right expectation over total number of forecasts.

$$Accuracy = \frac{True\ Positive + True\ Negative}{True\ Positive + True\ Negative + False\ Positive + False\ Negative}$$

On the basis of execution time we be comparing different optimization techniques. The execution time given here is machine specific. The results for the same has been shown in next section.

3.2Technology Used

MATLAB : MATLAB (Matrix Laboratory) is a fourth-age abnormal state programming language and intelligent condition for numerical calculation, perception and programming. MATLAB is created by Math Works. It allows number of tasks to be performed like network controls; capacity and information plot; finance calculations; UI production; assembling with projects that are written in different languages, including C, C++, Java, DotNet and Fortran; break down information; create calculations; and make models and applications. It has various worked in directions and math works that help you in scientific estimations, producing plots and performing numerical strategies. MATLAB is utilized in each aspect of computational arithmetic. I used MATLAB2015 version.

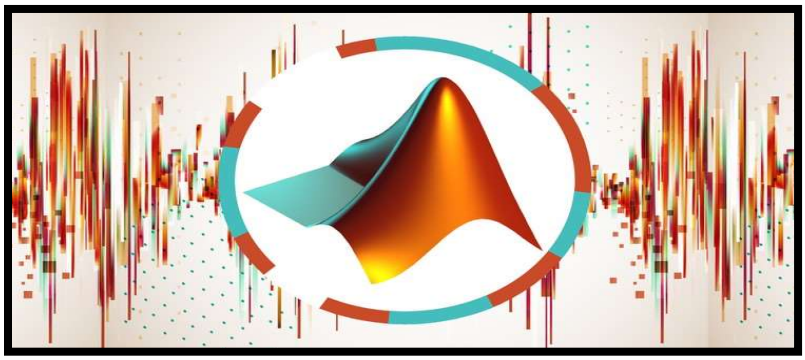

Fig 11: MATLAB logo

Features of MATLAB Following a TLAB:

- It is an different state language for numerical calculation, representation and application advancement.
- It likewise gives an intuitive domain to iterative investigation, plan and critical thinking.
- It gives tremendous library of scientific capacities for direct variable based math, insights, Fourier examination, separating, improvement, numerical joining and illuminating normal differential conditions. It gives worked in illustrations to imagining information and devices for making custom plots.
- MATLAB's modifying interface gives advancement instruments for improving code quality and viability and augmenting execution. It gives devices to building applications with custom graphical interfaces.
- It gives capacities to coordinating MATLAB based calculations with outer applications and dialects, for example, C, Java, .NET and Microsoft Excel.

- MATLAB is broadly utilized as a computational instrument in science and building incorporating the fields of material science, science, math and all designing streams.

It is utilized in a scope of uses including:

- Signal Processing and Communication Engineering
- Image & Video Processing
- Control Systems & Engineering
- Instrumentation and Measurement Engineering
- Accounts and Computational Finance
- Deep and Machine Learning
- Computational Biology

CHAPTER 4

RESULTS

This work intends to help the remedial piece of performing division and textural examination of mind from their MR images. We intend to have the framework which can recognize tumor at the most dependable and possible stage for the patients. Image division is utilized so as to extricate the most importance full data for medicinal examination. At that point, for surface investigation we will perform highlight extraction of GLCM features. PCA, ICA, and so on are utilized as feature reduction strategies. In our framework we proposed we related PCA and ICA together to decrease the estimation. Kurtosis is related some time later on ICA for mask of the parts having low trademark estimation of Kurtosis. The estimation of multifaceted nature, contrast and entropy is utilized for game-plan or we can say that these are the picked or highlight that can best demand the unsafe advancement in the MR/CT images. In this way, the creative data is gotten from the district of energy utilizing Haralick's texture features. To plan the type of treatment and classification of carciogenic lesions into classes like benign or malignant. We will be using SVM classifier and comparing results using other classifiers like A-NN and K-NN. The main goal of this machine learning approach in the area of medical imaging for detecting tumor into one of the classes as great or harmful. Thusly, GLCM features are disengaged utilizing faint estimation Co-event cross area. In the future, GLCM features are in like way chosen and the unsafe improvement are mentioned. Plan is the course toward interfacing at a choice for a masochist condition which is traditional or unusual. The going with layouts demonstrate the exactness and time execution examination of various systems separated and our methodology for example limiting the GLCM features utilizing ICA change looked for after by PCA. For confirmation kurtosis will be related with ICs which will remove the one with littler estimations of kurtosis than certain threshold(average).

The test was carried on the MATLAB 2015. The SVM device compartment has been utilized to play out the arrangement and testing stage. The proposed estimation can be completed on any structure with the above communicated MATLAB variation. The principal duty of the paper is that for the present methodology for brain tumor recognizable proof we have proposed a streamlining framework, for instance, PSO, PCA, ICA generally to diminish the data estimation of the set away database and to lessen the time required to execute the whole system. The figuring is shrewd enough to have any sort of impact between the normal and tumor mind reliant on its readiness experience.

The underneath figures are obtained as the results of classifier and the depictions of execution time and precision result with the GUI interface that is utilized in our machine.

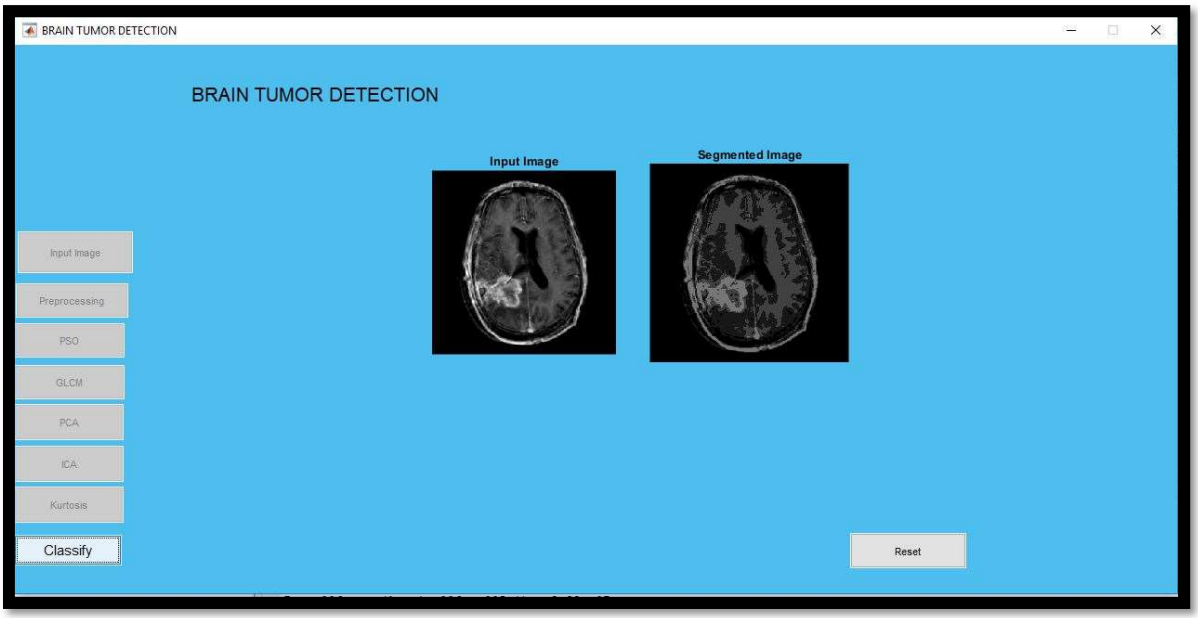

Fig 12: Results with PSO segmented image and Pre-processed image

The below figure gives us result after classification. For the given figure it classifies tumor into malignant class.

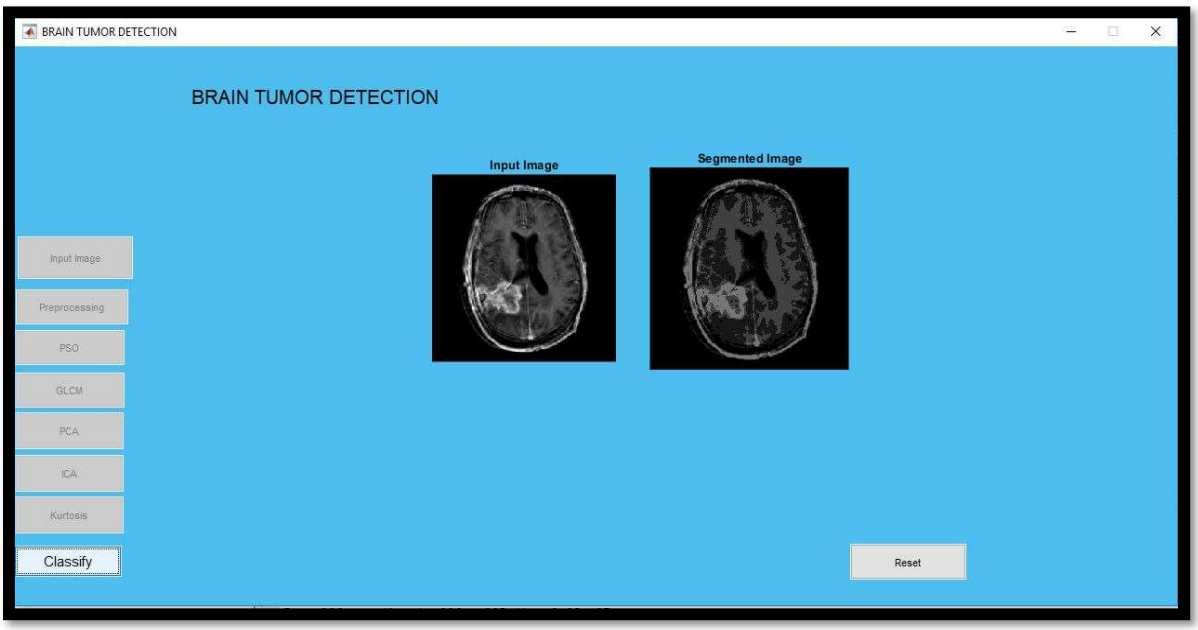

Fig 13: Results of classification

The accuracy of the proposed system has been formulated in the below graph, it contains the accuracy of PCA, ICAand combination of PCA and ICA (Proposed methodology). The combination of PCA and ICA is going to provide a higher accuracy and it is represented below. The results are shown with different classifiers. Here, we can see that our method

proves to be a novel and accurate technique in medical world for detection of tumor. The method is irrespective of classifier.

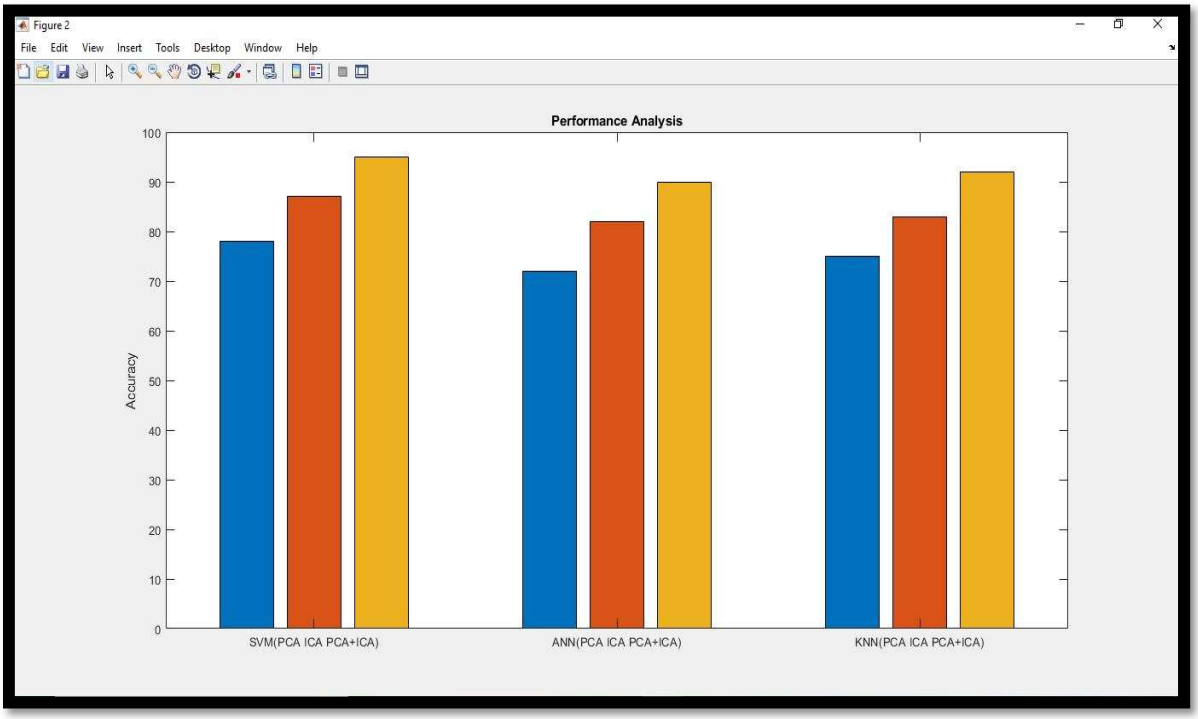

Fig 14: Accuracy comparison of different selection techniques

The time required to measure perform the feature extraction by different methods are listed in the below graph. Here also the combination of PCA and ICA is going to consume the more time to accumulate the features as shown

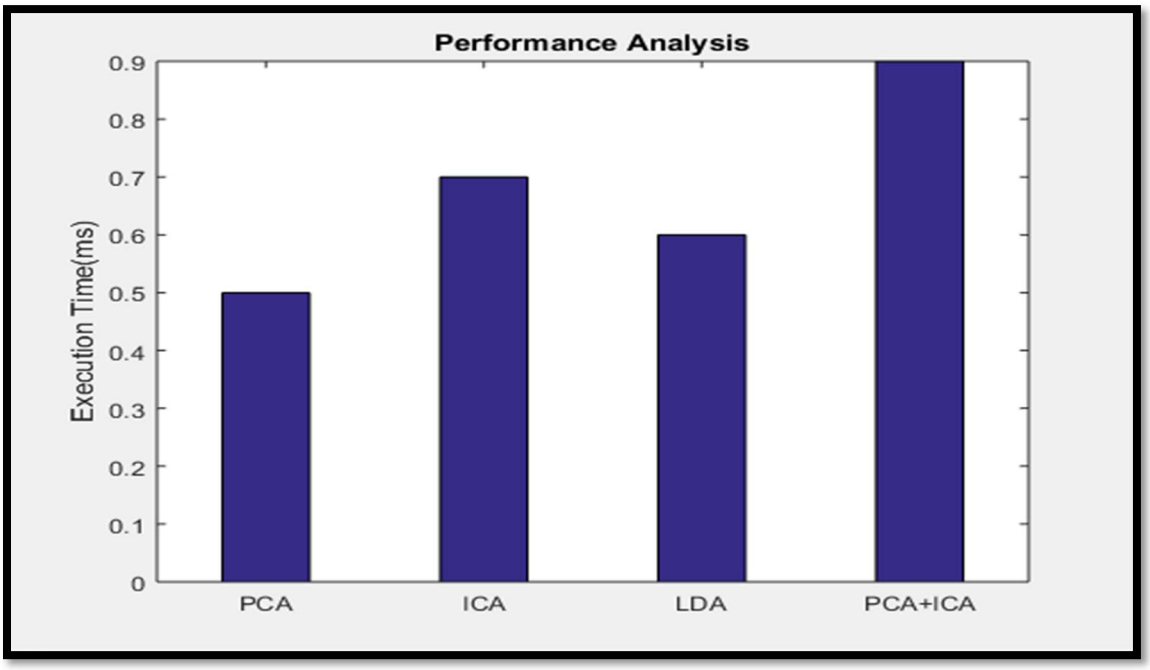

Fig 15: Execution time of different selection techniques

In our method, execution time is increased as compared to other methods previously given but for tumor detection matters more than time as it needs to be detected more accurately . So, there has to be tradeoff between accuracy and execution time.

CHAPTER 5

CONCLUSION AND FUTURE WORK

In Artificial based intelligence system used for brain tumor analysis, representation of the medicinal depiction in computerized framework is very crucial and important. This turns out to be inefficient when there is low illumination and brightness, low light or any external factors which leads to improper imaging. Studies have shown in past that surface data can improve precision of characterization and produce practically identical/best outcomes for diagnosis and medical treatment. Therefore, in order to communicate to such images in AI frameworks, surfacebased approach is very informational. In this paper, an optimal way for the tumor detection from brain MRI scan has been devised which on successful detection classifies the type: benign or malignant. The entire procedure mainly consists of four stages namely: preprocessing, feature extraction, feature reduction and classification. The proposed model is capable of detecting tumor by conducting pre-processing operations on input MRI images by employing the image filtering scheme and enhancement using histogram equalizer, for feature segmentation PSO (particle swarm optimization), PCA and Independent Component Analysis (ICA) used for feature reduction and finally the Support Vector Machines will be used for classifying the tumor whether that is benign or malignant in nature. From the conducted experiments it can be concluded that for detection of malignant tumor the accuracy rate is 92% which is significantly higher than the existent detection algorithms like using only PCA, ICA and LDA.

Imaging is an important job in the analysis and treatment of tumor in brain. The size and volume of tumor/lesion/cyst is an significant parameter in determining the effective treatment for any malignancy in brain. The estimation of volume and size of tumor will help the doctor to decide the treatment. The strategy we have used here is with PSO and PCA with ICA for texture analysis. But as future scope we can combine LDA with PSO as this will leads to better result as compared to PCA and ICA. This can lead to increased accuracy and efficiency. For medical analysis, PSO can be combined with FCM for better segmentation and analysis. The results are checked on different classifiers so that the result may not be classifier specific.

REFERENCES

1. Denise Leung, Xiaosi Han, Tom Mikkelsen and L. Burt Nabors , "Role of MRI in Primary Brain Tumor Evaluation", Journal of the National Comprehensive Cancer Network,2014
2. E. A. Zanaty, "Determination of gray matter (GM) and white matter (WM) volume in brain magnetic resonance images (MRI)," International Journal of Computer Applications, 2012.
3. A. Islam, S.M.S Reza, K.M Iftekharuddin, " Multifractal Texture Estimation for Detection and Segmentation of Brain Tumors", IEEE Transactions on Biomedical Engineering, Vol. 60, Issue 11, 2013, pp. 3204 -3215, ISSN: 1558-2531.
4. S. Bauer, C May, D Dionysiou, G. Stamatakos, P. Buchler, M. Reyes, " Multiscale Modeling for Image Analysis of Brain Tumor Studies", IEEE Transactions on Biomedical Engineering, Vol. 59, Issue 1, 2012, pp. 25 – 29, ISSN: 1558- 2531.
5. Anam Mustaqeem, Ali Javed, Tehseen Fatima," An Efficient Brain Tumor Detection Algorithm Using Watershed & Thresholding Based Segmentation", I.J. Image, Graphics and Signal Processing, 2012, 10, 34-39 Published Online September 2012 in MECS (http://www.mecs-press.org/)
6. Gauri P. Anandgaonkar , Ganesh.S.Sable," Detection and Identification of Brain Tumor in Brain MR Images Using Fuzzy C-Means Segmentation", International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 10, October 2013
7. James Kennedy , Russell Eberhart , "Particle Swarm Optimization" ,Proceedings of IEEE International Conference on Neural Network , 1995
8. R.M. Haralick, et al., Textural features for image classification, in IEEE Transactions on System, Man and Cybernetics
9. Hafiza Huma Taha, Syed Sufyan Ahmed, Haroon Rasheed,"Tumor Detection through Image Processing Using MRI", International Journal of Scientific & Engineering Research, Volume 6, Issue 2, February-2015 ISSN 2229-5518
10. Ivana Despotović, Bart Goossens, and Wilfried Philips," MRI Segmentation of the Human Brain: Challenges, Methods, and Applications",Computational and Mathematical Methods in Medicine Volume 2015, Article, ID 450341, http://dx.doi.org/10.1155/2015/450341
11. P. P. Gumaste, Dr. D. V. Jadhav,"Image Segmentation Techniques for Brain MRI Images: A Survey", International Journal of Modern Trends in Engineering and Research, e-ISSN No.:2349-9745, Date: 2-4 July, 2015
12. Anubha, R.B.Dubey,"A Review On Mri Image Segmentation Techniques", International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), ISSN: 2278 – 909X Volume 4, Issue 5, May 2015,
13. A. Kassner , R.E. Thornhill,"Texture Analysis: A Review of Neurologic MR Imaging Applications", American Journal of Neuroradiology May 2010, 31 (5) 809-816; DOI: https://doi.org/10.3174/ajnr.A2061
14. Claudia Chevrefils, Farida Cheriet, Member, IEEE, Carl-Eric Aubin, and Guy Grimard, "Texture Analysis for Automatic Segmentation of Intervertebral Disks of Scoliotic Spines From MR Images", IEEE Transactions On Information Technology In Biomedicine, Vol. 13, No. 4, July 2009

15. Bin Zhang, Jie Tian, Di Dong, Dongsheng Gu, Yuhao Dong, Lu Zhang, Zhouyang Lian, Jing Liu "Radiomics Features of Multiparametric MRI as Novel Prognostic Factors in Advanced Nasopharyngeal Carcinoma", American Association for Cancer Research, 10.1158/1078-0432.CCR-16-2910 Published August 2017

16. www.macs.hw.ac.uk/texturelab/files/publications/phds_mscs/MJC/ch4.pdf

17. M.K. Soumya, K. Snehaand C. Arunvinodh, "Cervical Cancer Detection and Classification Using Texture Analysis", Biomedical & Pharmacology Journal, Vol. 9(2), 663-671 (2016)

18. Somkait Udomhunsakul, Pichet Wongsita,"Feature Extraction in Medical MRI Images", Proceedings of the 2004 IEEE Conference on Cybernetics and Intelligent Systems Singapore, 1-3 December, 2004

19. David G. Lowe ,"Distinctive Image Features from Scale-Invariant Keypoints", International Journal of Computer Journal, August 2004

20. Sabiq Adzhani Hammam, Tito Waluyo Purboyo, Randy Erfa Saputra, "A Review Application Of Image Segmentation On Statistical Texture Analysis", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 20 (2017)

21. Adegoke, B.O, Ola, B.O, Omotayo, M.E,"Review of Feature Selection Methods in Medical Image Processing", Journal of Engineering (IOSRJEN) ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 04, Issue 01 (January. 2014),

22. Anissa Bouzalmat, Jamal Kharroubi,"Comparative Study of PCA, ICA, LDA using SVM Classifier", Journal Of Emerging Technologies In Web Intelligence, Vol. 6, No. 1, February 2014

23. I. V. Accamma, H. N. Suma, M Dakshayini, "A Genetic Algorithm Based Feature Selection Technique for Classification of Multiple Subject fMRI Data", IEEE International Advance Computing Conference (IACC),2015.

24. Neha Taneja and O.P. Sahu,"MRI Brain Tumor Segmentation Using Improved ACO", International Journal of Electronic and Electrical Engineering. ISSN 0974-2174, Volume 7, Number 1 (2014)

25. Issam El-Naqa, , Yongyi Yang, Miles N. Wernick, , Nikolas P. Galatsanos, Robert M. Nishikawa,"A Support Vector Machine Approach For Detection Of Microcalcifications", IEEE Transactions On Medical Imaging, Vol. 21, No. 12, December 2002

26. Rozy Kumari, Narinder Sharma,"A Study on the Different Image Segmentation Technique", International Journal of Engineering and Innovative Technology (IJEIT) Volume 4, Issue 1, July 2014

27. Hangfan Liu, Ruiqin Xiong, Jian Zhang and Wen Gao, "Image Denoising via Adaptive Soft-Thresholding Based on Non-Local Samples", 2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR) , June 2015

28. Tatiraju, Suman & Mehta, Avi. (2008). Image Segmentation using k-means clustering, EM and Normalized Cuts. University of California Irvine.

29. Salem Shah Al-ami, N.V Kalyankar, Khamitkar S.D. "Image Segmentation by using Threshold Techniques", Journal of Computing, 2010

30. Xue-xi ZHANG, Yi-min YANG,"Minimum Spanning Tree and Color Image Segmentation".
31. Dilpreet Kaur, Yadwinder Kaur,"Various Image Segmentation Techniques : A Review", International journal of Computer Science and Mobile Computing, Vol. 3, Issue 5, May 2014
32. Hetal J. Vala, Astha Baxi, "A Review on Otsu Image Segmentation Algorithm", International Journal of Advanced Research in Computer Engineering and Technology, Vol 2, Issue 2 , February 2013
33. Anubha Kale, Mr. Himanshu Yadav, Mr. Anurag Jain, "A Review: Image Segmentation using Genetic Algorithm", International Journal of Scientific & Engineering Research, Vol 5, Issue 2, Februrary2014
34. ASSAS Ouarda ,"Segmentation of MR Brain Images Using Particle Swarm Optimization (PSO) and Differential Evolution (DE)", IJCSI International Journal of Computer Science Issues, Volume 11, Issue 6, No 2, November 2014
35. Liping Zheng, Quanke Pan , Guangyao Li , Jing Liang, "Improvement of Grayscale Image Segmentation Based on PSO Algorithm", IEEE Fourth International Conference on Computer Sciences and Convergence Information Technology, November 2009
36. Fahd M. A. Mohsen, Mohiy M. Hadhoud, Khalid Amin, "A new Optimization-Based Image Segmentation method By Particle Swarm Optimization", International Journal of Advanced Computer Science and Applications, Special Issue on Image Processing and Analysis, Vol 4, Issue 3, December 2015
37. D.M. Joshi," Classification of Brain cancer using Artificial Neural Network", in International Conference on Electronic Computer Technology (ICECT)
38. S.N. Deepa, B.A. Devi, "Neural Networks and SMO based classification for Brain Tumors", inWorld Congress on Information and Communication Technologies (WICT)
39. Neelima Bagri, Punit Kumar Johari,"A Comparative Study on Feature Extraction using Texture and Shape for Content Based Image Retrieval", International Journal of Advanced Science and Technology Vol.80, 2015
40. L.Ladha, T. Deepa,"Feature Selection Methods And Algorithms", International Journal on Computer Science and Engineering (IJCSE), Vol. 3 No. 5 May 2011
41. Sahar Jafarpour, Zahra ,Mehdi Chehel,"A Robust Brain MRI Classification with GLCM Features", International Journal of Computer Applications (0975 – 8887) Volume 37– No.12, January 2012
    A. Martinez and A. Kak ,"PCA versus LDA", IEEE transactions on PA and MI,2001
42. V.P.Gladis Pushpa Rathi' and Dr.S.Palani,"A Novel Approach For Feature Extraction And Selection On Mri Images For Brain Tumor", CS & IT- CSCP 2012
43. Tzyy-Ping Jung and TE-Won Lee, "Imaging Brain Dynamics Using Independent Component Analysis", Proceeding of the IEEE, VOL. 89 NO.7, July 2001.
44. Nojun Kwak, Chong Ho-choi, Jin Young Choi, "Feature Extraction using ICA", IEEE conference , 2001
45. Xue-wen Chen, Xiangyan Zeng, Deborah van Alphen"Multi-class feature selection for texture classification" , Pattern Recognition Letters 2006
46. Roberto Manduchi, Javer Portilla, "Independent Component Analysis of Textures", ICCV, Kerkyra, 1990

47. Zhang Xu-siu, QIU Tian-shang, "The Study On The Principle Of Kurtosis Based ICA Method", IEEE Int. Conference on Neural Networks & Signal Processing, December 14-17, 2003
48. Sanjeev Kumar, Chetna Dabas, Sunila Godara "Classification Of Brain MRI Tumor Images: *A* Hybrid Approach", 5th International Conference on Information Technology and Quantitative Management, ITQM 2017
49. Hari Babu Nandpuru , Dr. S. S. Salankar , Prof. V. R. Bora,"MRI Brain Cancer Classification Using Support Vector Machine", IEEE Students' Conference on Electrical, Electronics and Computer Science, 2014
50. Tim Adams, Jens Dörpinghaus, Marc Jacobs and Volker Steinhage,'Automated lung tumor detection and diagnosis in CT Scans using texture feature analysis and SVM', Communication Papers of the Federated Conference on Computer Science and Information Systems,2018
51. Pratiksha M. Patel, Dr. Sanjay M. Shah,"Comparitive analysis for Pre-Processing of Images and videos using Histogram Equalization methodology and Gamma correction method",International Research Journal of Engineering and Technology (IRJET)
52. "Principal Component Analysis for Dimensionality Reduction" : PCA for Dimensionality Reduction
53. Nicola Falco, Lorenzo Bruzzone, Jon Atli Benediktsson,"An ICA Based Approach To Hyperspectral Image Feature Reduction", IEEE Geoscience and Remote Sensing Symposium 2014
54. Wei Zhao and Yuehong Shen, "New Kurtosis Optimization Algorithms for Independent Component Analysis", IEEE conference on Electronics and Communication, 2014
55. Nalin Kumar, M. Nachamai, "Nosie Removal and Filtering Techniques used in Medical Images", Oriental joutrnal of computer science and technology,2017
56. Wan Azani Mustafa, Mohamed Mydin M. Abdul,"A review on Histogram equalization Techniques in Image Enhancement Application", International Conference of Green and Sustainable Computing.2017
57. Dinesh Sonker,M.P. Parsai, "Comparison of Histogram Equalization Techniques for Image Enhancement of Grayscale images", International Journal of Modern Engineering Research, 2013
58. Amanpreet Kaur, M.D. Singh ,"An Overview of PSO- Based Approaches in Image Segmentation", International Journal of Engineering and Technology Vol. 2, Issue 8, August 2012
59. Q. Gao, L. Zhang1, D. Zhang and J. Yang,"Matrix FastICA Algorithm and Its Application to Face Recognition", Transactions on Pattern Analysis and Machine Intelligence, March 2010
60. Jari Miettinen, Klaus Nordhausen, and Sara Taskinen,"fICA: FastICA Algorithms and Their Improved Variants",The R Journal ISSN 2073-4859 Vol. 10 Issue 2, December 2018
61. "Classification for texture analysis" : Need for classification
62. "Support Vector Machine Algorithm" : SVM Algorithm for Classification
63. "MATLAB" : Study about MATLAB