# Brain Tumor Detection and Classification


Prof. Poonam Bhogle

- Apurva Mehta 1411093
- Hitesh Jaiswal 1411026
- Shreyansh Kotak 1411025
- Yash Pasar 1411038

Department of Computer Engineering

**K. J. Somaiya College of Engineering**

# Problem Definition

Our study deals with automated brain tumor detection and classification.

Normally the anatomy of the brain is analyzed by MRI scans or CT scans.

Our system aims to detect the tumor from the given MRI scan and then classifies the tumor as malignant or benign.

# Scope

Our aim is to develop an automated system for enhancement, segmentation and classification of brain tumors.

The system can be used by neurosurgeons and healthcare specialists.

The system incorporates **image processing**, **pattern analysis**, and **computer vision techniques** and is expected to improve the sensitivity, specificity, and efficiency of brain tumor screening.

The proper combination and parameterization of above phases enables the development of adjunct tools that can help on the early diagnosis or the monitoring of the therapeutic procedures.

# Requirements

## Software Requirements

MATLAB 2017b or later

Operating System: Windows 7 SP1 or later, macOS Yosemite or later

## Hardware Requirements

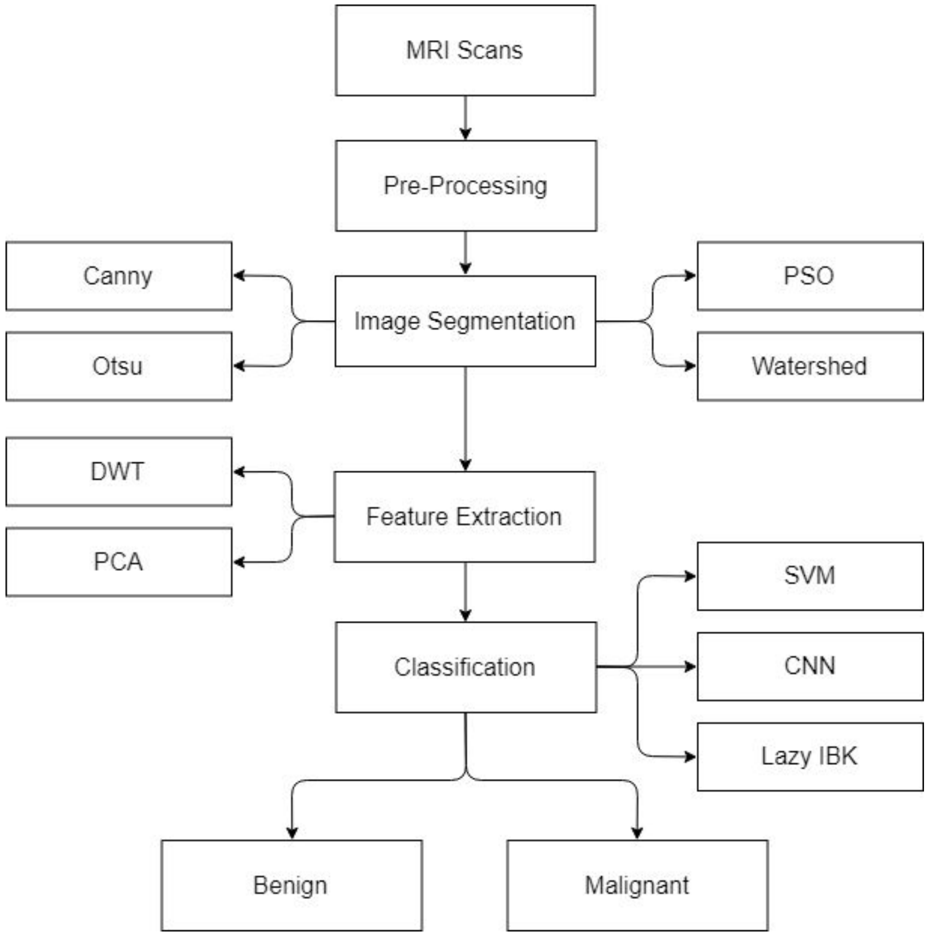
Processor: Any Intel or AMD x86-64 processor

RAM: 8 GB

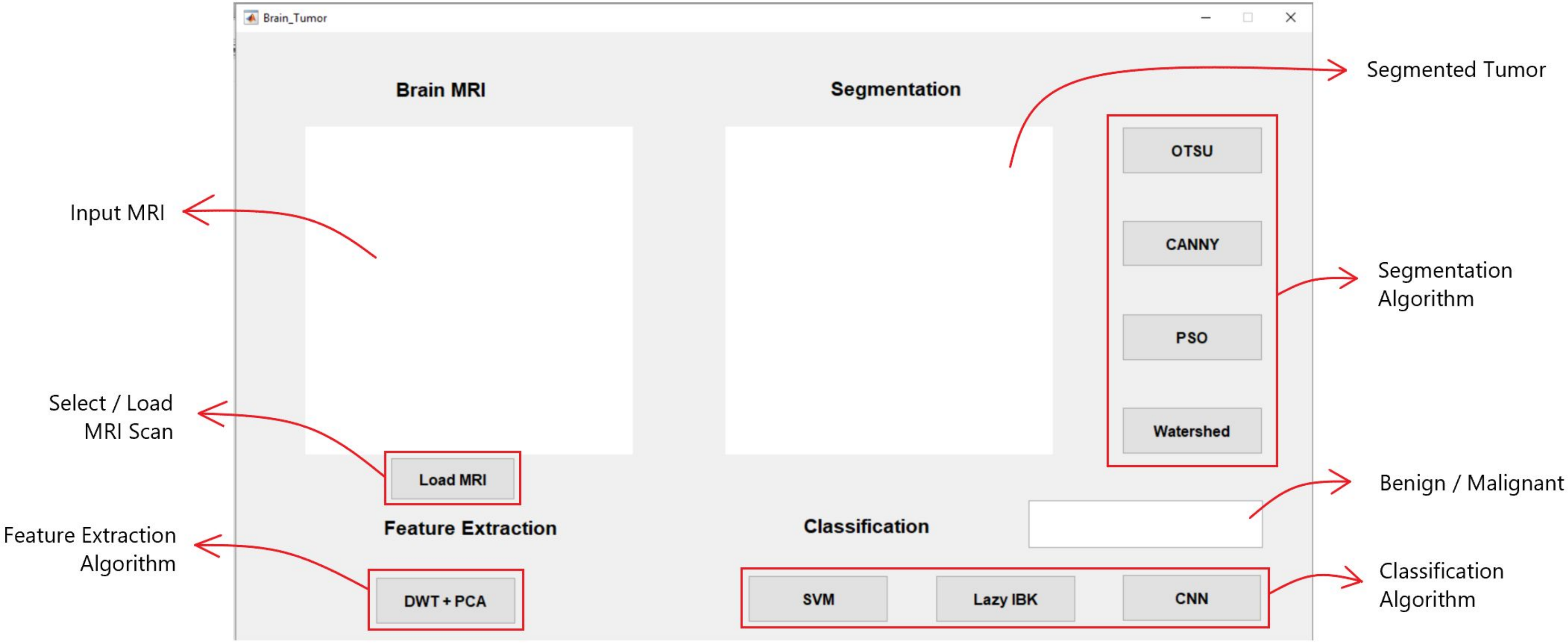
Disk Space: 8 GB

Graphics: Hardware accelerated graphics card supporting OpenGL 3.3 with 1GB GPU memory

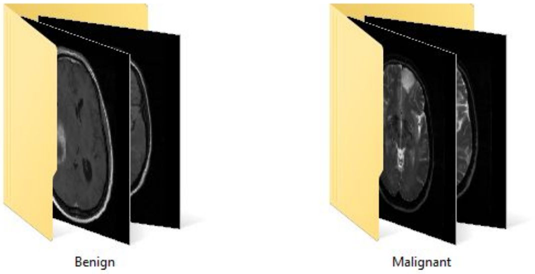
# Software Architecture Diagram



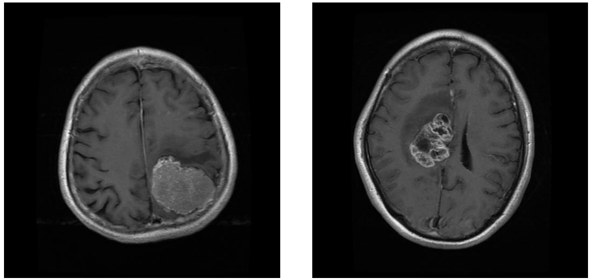
# Graphical User Interface (GUI)



# MRI Scans




Segregated Dataset



Sample MRI Scans

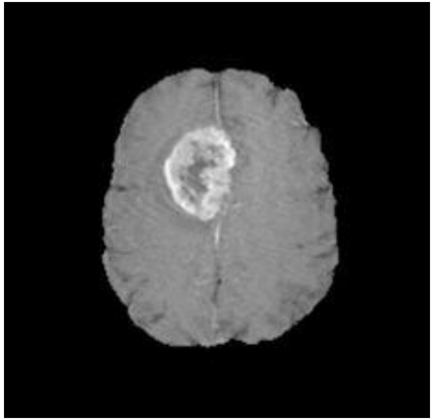
MRI scans of brain are taken as the input for all training and testing purposes.

The images are Grayscale and are resized to 256x256 px for processing.

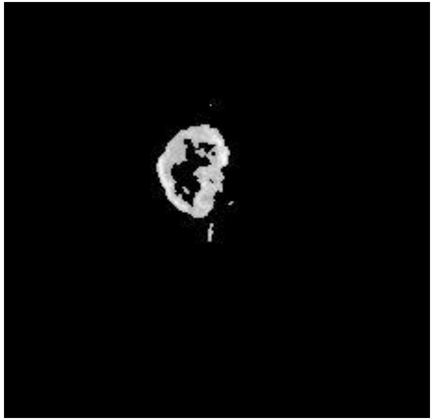
It is assumed that all the images given input to the system are either Benign (Non-cancerous) or Malignant (Cancerous).

The images are separated into two labeled folders for training and testing purpose only.

# Segmentation



Original MRI Scan



Segmented Tumor Image

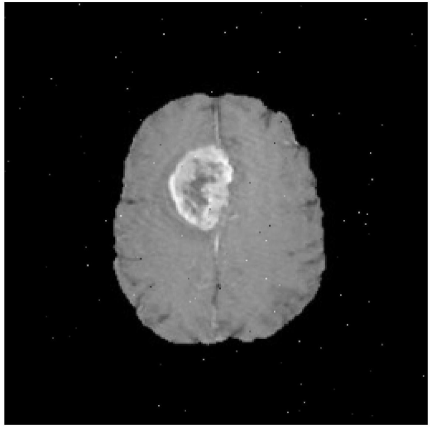
Segmentation is the most crucial step in identification of Tumor.

This step extracts the tumor from the MRI scans which is then sent for extracting features.

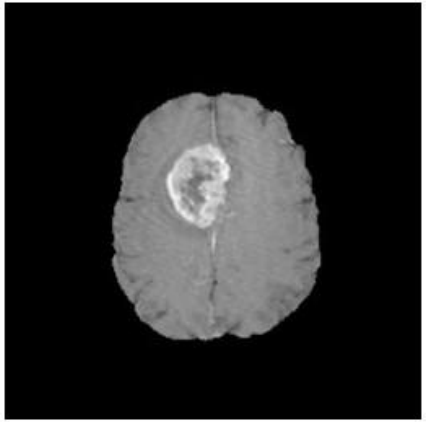
Following are the segmentation algorithms that have been implemented:

1. Canny
2. Otsu
3. Watershed
4. PSO

# Pre-processing



Before Pre-processing with Noise



After Pre-processing without Noise

Median filtering is a common image enhancement technique for removing salt and pepper noise.

Weighted median filtering technique gives better results compared to median filter, adaptive filter and spatial filter.

Gaussian filter is also used to smooth the image and get rid of noise.

The MRI scanning machines are very precise with almost no noise in the images.

# Segmentation

## Canny Algorithm

Edge detection is the approach used most frequently for segmenting images based on abrupt change in intensity.

The canny edge operator works in a multi stage process.

Canny algorithm is capable of yielding a totally unbroken edge for the posterior boundary of the brain.

# Segmentation

## Otsu Algorithm

Otsu’s thresholding is a non - linear operation that converts a grayscale image into a binary image where the two levels are assigned to pixel those that are below or above the specified threshold value.

The algorithm assumes that the image contains two classes of pixels following bi-modal histogram:

- Foreground pixels
- Background pixels

It then calculates the optimum threshold separating the two classes so that their combined spread (intra-class variance) is minimal and inter-class variance is maximal

# Segmentation

## Watershed Algorithm

Watershed segmentation is a gradient - based segmentation technique.

It assumes that any grayscale image can be viewed as a topographic surface where:

- High intensity denotes peaks and hills
- Low intensity denotes valleys

It is suitable for the images that have higher intensity value.

This approach may give over-segmented result due to noise or any other irregularities in the image.

# Segmentation

## Particle Swarm Optimization (PSO) Algorithm

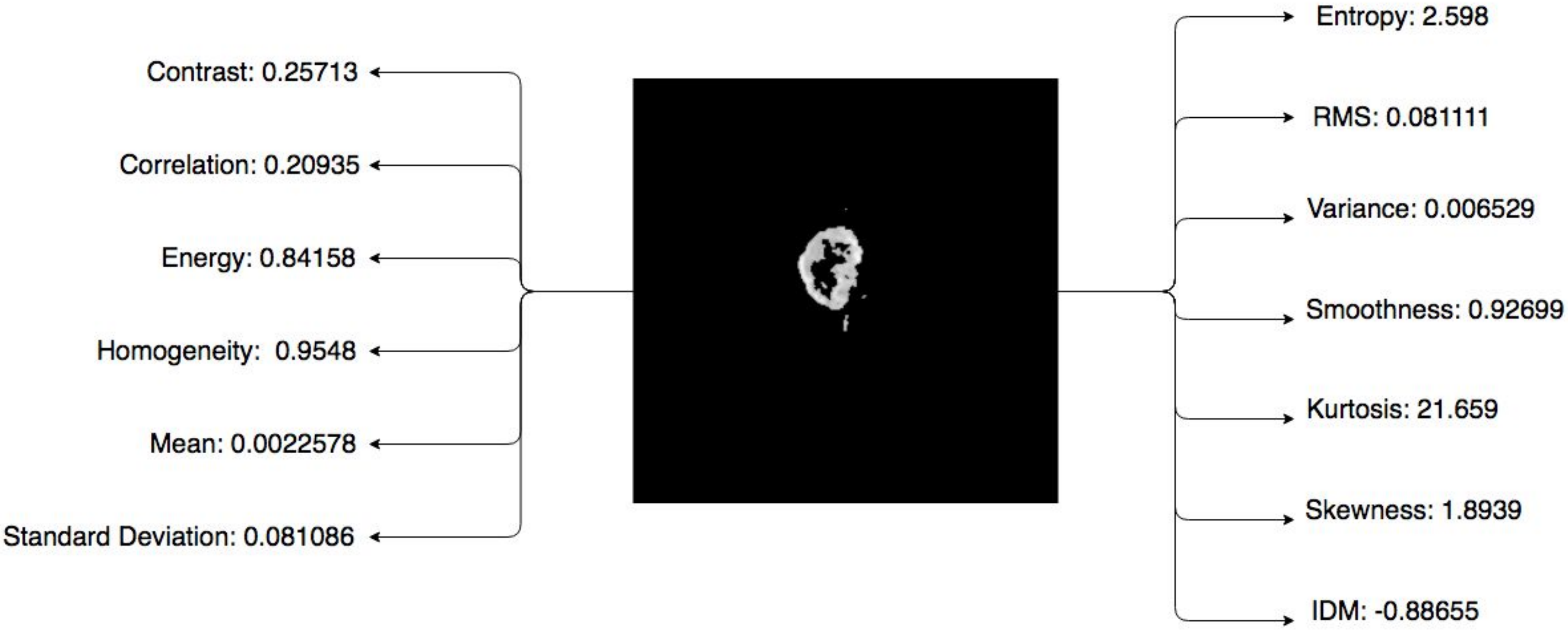
Particle Swarm Optimization (PSO) algorithm is based on swarm intelligence.

All particles have a fitness value evaluated by a fitness function and a velocity data that orients their fights.

PSO algorithm starts with a group of random generated solutions (particles) and optimal solution is investigated iteratively.

Out of the 4 segmentation algorithms used, PSO gives the best segmentation results.

# Feature Extraction



# Feature Extraction

## Discrete Wavelet Transform (DWT) & Principal Component Analysis (PCA) Algorithm

Discrete Wavelet Transform (DWT) is used in combination with Principal Component Analysis (PCA) to extract image features from the segmented MRI scans.

DWT is used to extract coefficient of wavelets from brain MR images.

The wavelet localizes frequency information of signal function which was important for classification.

PCA is used to reduce the large dimensionality of the data.

PCA computes the Eigen vectors of the covariance matrix and approximates it by a linear combination of the leading eigenvectors.

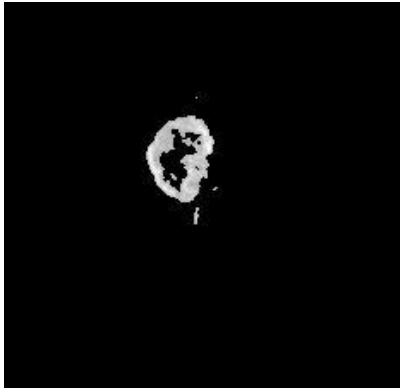
# Feature Extraction

## List of Extracted Features

GLCM Features

1. Correlation
2. Contrast
3. Energy
4. Homogeneity
5. Mean
6. Standard Deviation
7. Entropy
8. Root Mean Square (RMS)
9. Variance
10. Inverse Difference Movement (IDM)
11. Kurtosis
12. Skewness
13. Smoothness

# Classification



**Classification:**

Benign

This requires the system to train first using classified MRI scans and then based on trained data classify the test images.

This step classifies the Brain Tumor MRI scan as:

1. Benign (Non-Cancerous)
2. Malignant (Cancerous)

Following are the classification algorithms that have been implemented:

1. Support vector machine (SVM)
2. Lazy IBK
3. Convolutional Neural Network (CNN)

# Classification

## Support Vector Machine (SVM)

Support Vector Machine (SVM) is a non-probabilistic binary linear classifier.

A SVM takes the set of feature vectors as input, generates a training model after scaling, selecting and validating, and generates a training model as the output.

This training model is then used to classify the image as either benign or malignant based on the features generated from the feature extraction step.

The accuracy relies completely on the accuracy of features extracted during training and testing.

# Classification

## Lazy IBK

Lazy IBK is instance based k-nearest neighbor semi-supervised learning algorithm.

Instance-based (IB) learning methods simply store the training examples and postpone the generalization (building a model) until a new instance must be classified or prediction made.

The instance based k-nearest neighbor is a semi-supervised learning algorithm. It requires training data and a predefined k value to find the k nearest data based on distance computation for each instance. If k data have different classes, the algorithm predicts class of the unknown data to be the same as the majority class.

# Classification

## Convolutional Neural Networks (CNN)

Convolutional Neural Networks (CNNs) are similar to traditional neural networks, except CNN unlike neural networks, where the input is a vector, here the input is a multi-channeled image.

This algorithm does not use the features from the feature extraction step to classify the tumor.

It uses a neural network generated from the segmented images of training data to classify the tumor.

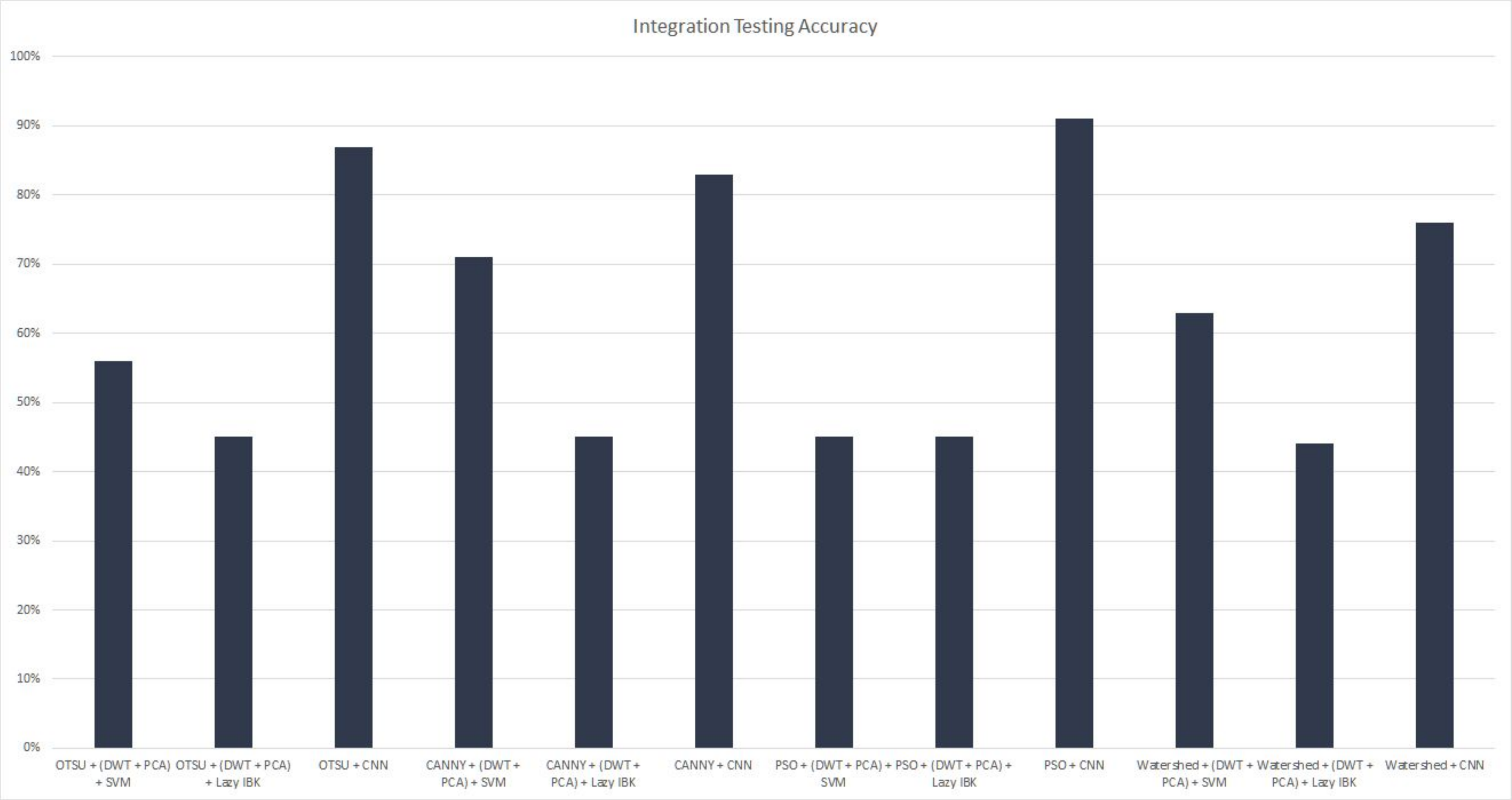
The training can take minutes and even hours based on the volume of training data.

CNN provides the best result of the 3 classification algorithms used.

# Results

## Integration Testing Accuracy

| Test Case: | Accuracy |
|---|---|
| OTSU + (DWT + PCA) + SVM | 56% |
| OTSU + (DWT + PCA) + Lazy IBK | 45% |
| OTSU + CNN | 87% |
| CANNY + (DWT + PCA) + SVM | 71% |
| CANNY + (DWT + PCA) + Lazy IBK | 45% |
| CANNY + CNN | 83% |
| PSO + (DWT + PCA) + SVM | 45% |
| PSO + (DWT + PCA) + Lazy IBK | 45% |
| PSO + CNN | 91% |
| Watershed + (DWT + PCA) + SVM | 63% |
| Watershed + (DWT + PCA) + Lazy IBK | 44% |
| Watershed + CNN | 76% |



Integration Testing Accuracy
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
OTSU + (DWT + PCA) + SVM
OTSU + (DWT + PCA) + Lazy IBK
OTSU + CNN
CANNY + (DWT + PCA) + SVM
CANNY + (DWT + PCA) + Lazy IBK
CANNY + CNN
PSO + (DWT + PCA) + SVM
PSO + (DWT + PCA) + Lazy IBK
PSO + CNN
Watershed + (DWT + PCA) + SVM
Watershed + (DWT + PCA) + Lazy IBK
Watershed + CNN

# Future Scope

The aim of the system is to act as an assistive technology to aid neurosurgeons and radiologists.

The system can be integrated with cloud platform where medical scans from partner MRI centers can be made available to train the system with new training set.

Real time classification can be made possible by integrating Artificial Intelligence (AI) with the developed Brain Tumor Detection and Classification system combined with live input from the MRI scanning instrument.

# Thank You