Brain Tumor Detection and Classification using Metaheuristic Optimization Techniques

A Dissertation submitted in partial fulfillment of the requirement for the

Award of degree of

MASTER OF TECHNOLOGY

IN

SIGNAL PROCESSING AND DIGITAL DESIGN

Type text here

Submitted By

HIMANSHU SHARMA

(2K19/SPD/07)

Under the esteemed guidance of

Dr. M.S CHOUDHRY

Professor

DEPARTMENT OF ELECTRONICS &COMMUNICATION

DELHI TECHNOLOGICAL UNIVERSITY

DELHI-110042,

Session 2019-2021

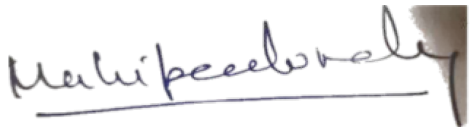
DECLARATION

I Himanshu Sharma (2k19/SPD/07) student of M.Tech (Signal Processing and digital design), hereby declare that project Dissertation Title "Brain tumor detection and Classification using Metaheuristic Optimization Techniques" which is submitted by me to the department of Electronic 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 Associate ship, Fellowship or other similar title or recognition.

Place: Delhi Himanshu Sharma

CERTIFICATE

I hereby certify that the Project Dissertation Title "Brain tumor detection and Classification using Metaheuristic Optimization Techniques" which is submitted by Himanshu Sharma (2k19/SPD/07) department of Electronic and Communication Engineering , 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 students 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.



Signature

Prof. M.S. Choudhry
Department of Electronics & Communication
Delhi Technological University(DTU), Delhi

Place : Delhi

ABSTRACT

The brain tumor is a very common disease among humans, it can be deadly if not diagnosed in its early stage. Magnetic Resonance Imaging (MRI) is commonly used technique to diagnose cancer but despite providing highly valuable information regarding tumor, it also prone to give human error. Recently, various Computer-Aided Diagnosis (CAD) techniques are being developed to improve performance of MRI. Computer vision systems make this process automatic and more accurate detection so that diagnosis can be done properly. Here presents a general Metaheuristic algorithm followed by review on different Metaheuristic Optimization Techniques based CAD systems which provides better detection and classification results for MR Images. The word Meta means “trial and run” and heuristic means an “approach” to find a solution, so together metaheuristic is a method that uses a trial and run approach to find an effective solution.

Our main aim here to detect the tumor type whether it is in benign stage or in malignant stage. This is done basically with help of mainly 4 steps namely Enhancement- which is particularly removing the noise, Segmentation – which makes the effected region visible , Feature Extraction/selection- which helps to extract the features which helps in classifying the tumor and finally Classification-which identifies the type of tumor.

Acknowledgments

First of all, I would like to thank my advisor and guide Prof. M.S. Chaudhary, who has been the guiding force behind this work. I want to thank him for introducing me to the field of image processing and giving me the opportunity to work under him. I consider it my good fortune to get the opportunity to work with such a skilled person.

I would like to thank the respective faculty members and staff of the Department of Electronics and Communication Engineering, D.T.U., Delhi for their generous help in various ways for the completion of this report.

I would like to thank my friends. I am also thankful to my classmates for all the thoughtful and mind stimulating discussions we had, which prompted me to think beyond the obvious.

Himanshu Sharma

TABLE OF CONTENTS

LIST OF FIGURE

CHAPTER 1

INTRODUCTION

1.1 Background

According to the database approved by the American Society of Clinical Oncology (ASCO), brain cancer ranks 10th among the causes of death. It has a high mortality rate of 2.5% per 100000 persons examined with a survival rate of approximately 5 years. The brain tumor is fully curable if it is detected in its early stage. Therefore, it is important to identify the tumor in its initial stage. Currently, there are several techniques which are used by neurologists to detect brain tumor namely; Computer Tomography Scan (CTS), Magnetic Resonance Imaging (MRI), Angiography, etc. However, due to the reasons like complexity and inaccuracy, these techniques are prone to human error which may lead to inaccurate results. To prevent this, a Computer-Aided Diagnosis (CAD) has been developed.

A conventional CAD system has 5 stages namely: Image Acquisition, Preprocessing, Segmentation, Feature Extraction/Selection and Classification. 1. Image Acquisition- image is acquired in the system from source. 2. Preprocessing – Here the image which is acquired is further processed so that some unwanted noise is removed through various filters like median filter, Gaussian filters etc. 3. Segmentation- This step helps to segment the desired region from the images mainly the affected region is taken out and the unwanted part of image is discarded some methods like water shed method, clustering method, threshold method etc. are used. 4. Feature Extraction and Selection – Here some of feature of the image are extracted mainly texture based feature are taken into consideration like entropy, energy, correlation etc. in case of feature selection out of whole lot features, few are selected based on certain criteria/conditions, these selected features are then used further in classification step and helps to classify the type of tumor, methods like genetic algorithm, others optimization algorithms can be used. 5. Classification- using various classification method like SVM, neural network etc. the extracted image is classified and defined as malignant or begin tumor. CAD assists in better detection and classification of brain tumors. This paper mainly focuses on metaheuristic optimization-based CAD system.

Optimization is a process of finding the best fit solution for the required problems which are from different fields. There are different types of Optimization Techniques which are divided based on focus and characteristic, the researchers have called all modern Nature-Inspired division algorithm as Metaheuristic. The word Meta means “trial and run” and heuristic means an approach to finding a solution so together metaheuristic is a method that uses a trial and run approach to find an effective solution. It is very effective and can also be used for nonlinear function optimization. There are mainly 2 important components under any metaheuristic algorithm namely intensification and diversification. Intensification mainly focuses on local search based while diversification is a global search-based category. In the recent scenario, these techniques are gaining popularity in the field of medical imaging.

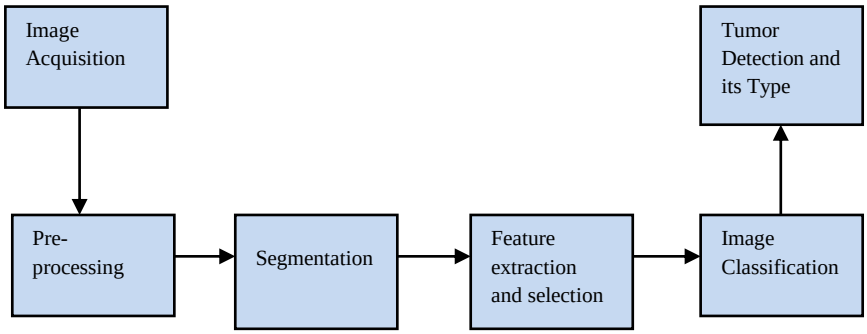


Fig.1 Brain tumor detection Flow graph

This thesis reviews techniques like Artificial Bee Colony (ABC), Ant Colony Optimization (ACO), Cuckoo Search (CS), Bat Algorithm (BA), Differential Evolution (DE), Firefly Algorithm (FA), Genetic Algorithm (GA), Grey Wolf Optimization (GWO), Harmony Search (HS), Krill Heard Optimization (KH), Level Set (LS), Monkey Search (MS), Particle Swarm Optimization (PSO), Stimulated Annealing (SA), Water Cycle Algorithm (WCA).

1.2 Literature Survey

H. Emrah et al. [1] discussed the use of the Artificial Bee Colony Algorithm (ABC) which is famous for diverse real-world problems. The algorithm is explained using the bee foraging nectar method which tries to find the best solution. They explain its working and also compare it with other methods like Genetic Algorithm (GA), Fuzzy C-means, and K-means to show its better accuracy result.

M. Lee et al. [2] give an insight into Ant Colony Optimization (ACO) which is inspired by the behavior of Swarms Intelligence. Its performance based on self-organization which mainly depends on the control over Swarm members. Here the result shows that even a thin layer of tumor is segmented which leads to better detection.

C. Priyadharshini et.al [3] covers the Bat Algorithm which is based on the bat ability of echolocation, each bat has a particular frequency and sound which helps them to find their target (fitness function), so in this process of finding target, we can change amplitude and pulse rate emission to get different targets or fitness function. It further compares the overall accuracy which is improved with the use of this algorithm.

E. Ben George et.al [4] the authors cover another widely used algorithm i.e., Cuckoo Search algorithm which follows the brood parasitism and levy flight method to get an optimally fit solution. They explain its working and also compare with other methods to show its accuracy.

M. Ramadas et.al [5] authors tells about Differential Evolution technique and discuss about its unique behavior of mutation and crossover which makes it different from other evolutionary algorithm . Furthermore, the transferred DE is used to find an optimal thresholding so that the final accuracy of detecting brain tumor increases.

M. P. S. Deshpande et.al [6] authors discuss the Firefly Algorithm which tells about the nature of firefly (solution) been attracted towards brightest fireflies (fitness function) to communicate with their neighbors which is used in detecting brain tumor.

A. Halder et.al [7] authors propose the very common optimization problem namely Genetic Algorithm (GA) which is basically founded in 1975 it comes under evolutionary algorithm; it works similarly like a natural evolution and modifies a population of individual at each stage of evolution. They also discuss that how it can be used to reduce the error from the

final classification output.

T. Attar et.al in their paper [8] authors talk about Grey Wolf Optimization Algorithm which has works analogy like wolf hunting in a pack, with fitness function can be quality of positioning of the wolf, and there is relocalization of the wolf on seeing the enemy which can be treated as reinitialization. They also discuss that how it can be used to reduce the error and increased computation time which results in better detection.

O. Moh et.al in their paper [9] authors cover the modified Harmony Search Algorithm and state how the nature of skilled musicians can be effectively used to improved segmented output than commonly used methods like fuzzy C-means etc.

J. Preethi et.al [10] authors discuss the Krill Herd approach of finding the best solution, which is usually based upon herding process to find the food (best solution). This method is also compared with other methods and in the end; it is shown how final accuracy has been increased.

Hassan A. Khalil et.al [11] authors tell us about the Level Set Algorithm and how it is used to detect brain tumor in brain MR images using interface surface to detect the brain contour, it also compares its performance with other methods like Fuzzy c-means, SVM, random forest, etc. and states how it increase the overall accuracy.

S. Alagarsamy et.al [12] authors discuss the behavior of Monkey characteristics of finding food which includes mainly climb, watch jump, somersault steps mainly they act as a local optimizer, fitness exploration and exploring new regions respectively it compare the performance with other algorithms also and tell us about how effective this technique in detecting brain tumor.

A. Dixit et.al in their paper [13] authors discusses another technique which is Particle Swarm Optimization. It is a very effective technique and now widely used in detecting brain tumor. The algorithm states the nature of particle swarm and explains how they are finding the particle best(pbest), global best(gbest), local best (lb) solutions This method is also compared with other methods and in the end, it is shown how final accuracy has been increased.

M. Ben Ayed et.al in their paper [14] authors discuss the Simulated Annealing method, where the nature of slow cooling is appreciated in making crystal and uses this method to improve the accuracy, which helps in the classification of brain tumor more accurately.

N.Ara et.al in their paper [15] authors tells the Water Cycle Optimization techniques which usually have 3 steps like precipitation (random initialization), percolation (finding the best solution), and evaporation (reinitialization of solution).In the end increased accuracies of the brain tumor detection is also discussed.

1.2 Aim

Our main aim to detect the tumor with the help of optimization technique which further classify the tumor as malignant and benign.

1.3 Motivation

The motivation of the proposed application is to aid neurosurgeons and radiologists in detecting brain tumors in an inexpensive and non-invasive manner.

1.4 Scope

Our aim is to develop an automated system for enhancement, segmentation and classification of brain tumors, which could aid the neurosurgeons and healthcare specialists. Such system can be made with low hardware and installation cost and can reach to small and big hospitals of the countries.

CHAPTER 2

PROPOSED WORK

I have considered a dataset of 35 brain MR Images. Of these 35 images, 20 images are used for the training purpose of classifiers (8 normal, 12 abnormal) and rest 15 images are used for the testing (6 normal, 9 abnormal) of the trained classifier so as to know the performance parameters that are Accuracy, Sensitivity and Specificity. This whole thesis is basically a two-step framework. In the first step the whole procedure is done without feature selection and in the next step the same procedure is repeated but this time with feature selection application using modified particle swarm optimization technique. The whole procedure is explained in detail below

2.1 IMPLEMENTATION WITHOUT FEATURE SELECTION

Firstly the dataset is taken and feature extraction is done. Here texture features are extracted from images which discriminates one class of images (normal images) from the another class (abnormal images). Total ten texture based features are extracted from the images that are mentioned below:

i. Energy
ii. Entropy
iii. Correlation
iv. Variance
v. Inertia
vi. Angular Second Moment (ASM)
vii. Inverse Difference Moment (IDM)
viii. Cluster Shade
ix. Cluster Prominence
x. Contrast

These ten features are extracted from all the training and testing images dataset. Thus we get two types of feature matrix, one is training feature matrix which contains the features of training dataset and other is testing feature matrix that contains features of testing dataset. Firstly the training feature matrix is used for the training purpose of the supervised classifiers used in this process. Support Vector Machine (SVM) classifier with different kernel function are used in these process.

Now the trained classifier's performance is tested based on the testing feature set matrix. These trained classifiers classifies the testing images as normal or abnormal based on working criterion of each classifier. The performance is based measured based on three parameters:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Sensitivity = \frac{TP}{TP + FN}$$

$$Specificity = \frac{TN}{TN + FP}$$

Where TP= true positive , TN = true negative, FN= false negative, FP= false positive.

2.2 IMPLEMENTATION WITH FEATURE SELECTION

This is the second step of the proposed framework. In this step we are doing the proposed work with feature selection . The feature selection is the process of reducing the complete set of feature to the useful set of feature which is having the reduced dimension, but this process could increase the complexity of feature set. So what is the main aim of doing feature selection is to reduced the feature set while keeping in mind the performance of classification. The feature selection criteria is done based on the proposed application.

The feature set is represented by a binary string of 0s and 1s. The features which are included are represented by 1s and those which are not included are represented by 0s. A fitness function is used for this feature selection process and output obtained by the fitness function is given as a feedback to the system to know whether the stopping criterion is met or we have to keep on generating new generations more. In this way a best feature set which is of reduced dimensions is found for every classifier and corresponding performance parameters are also calculated. From the results we can see that the performance of the classifiers is

being increased by using this concept of feature selection. We are using modified particle optimization techniques as mention below:

Proposed Technique

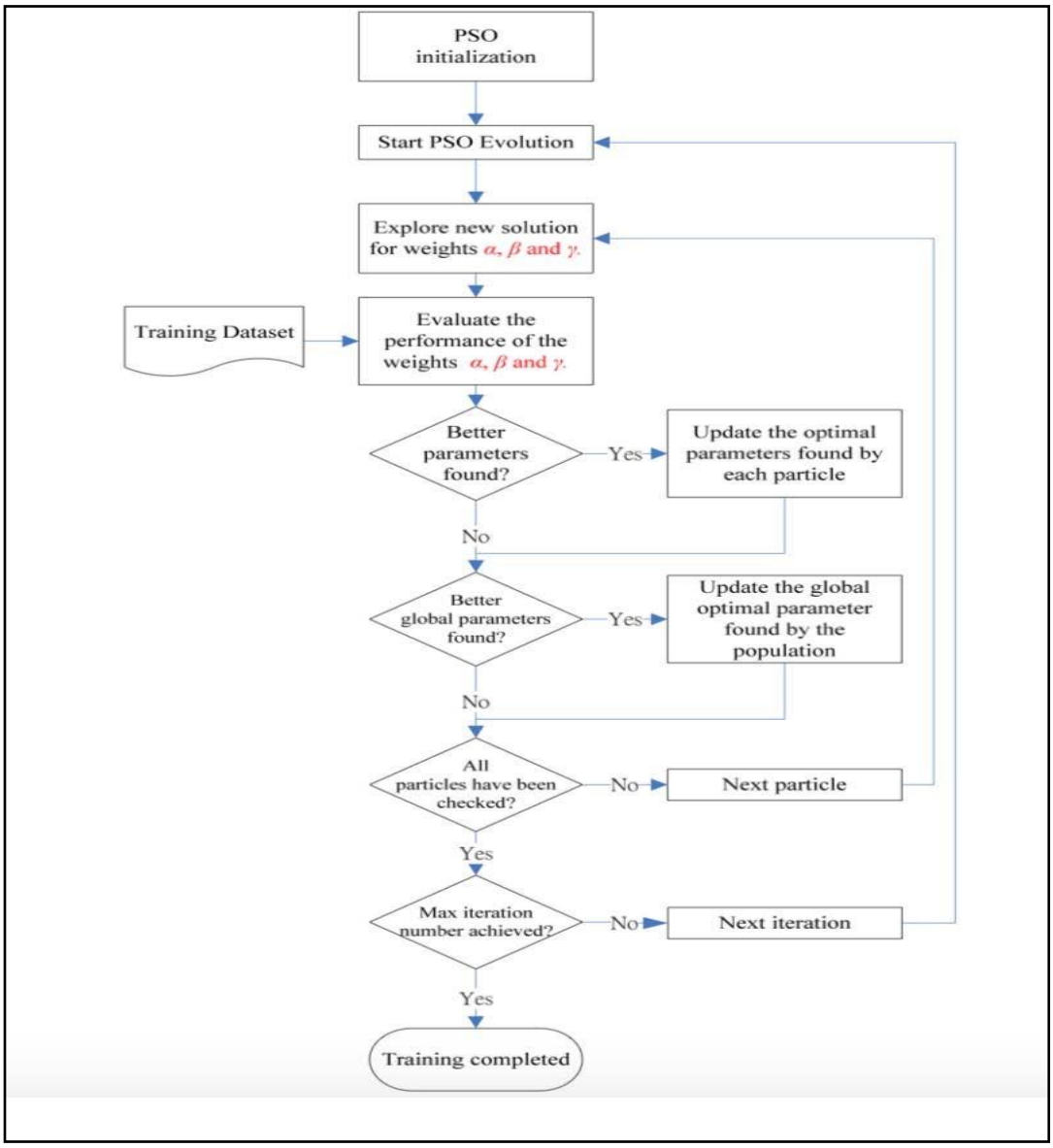


Fig.2 Algorithm of Proposed metaheuristic technique

Modified techniques is used to do the feature selection which helps to divide the best feature subset. Best feature subset is calculated for image and based on the value of *average* parameter, best classifier is defined for every part and their corresponding class results are stored.

CHAPTER 3

PREPOCESSING STEPS

This chapter discusses the all the prerequisites that is followed in the project. It also identifies what the project is actually doing in short.

It is also known as image restoration. When image acquisition is done using sensors, noises are introduced in the image and it may be possible that intensity level at some points may be changes, distorted. Generally the data should be pre-processed before the application of vision system to image data for the purpose of classification or detection, so as to ensure that it satisfies certain assumptions required by the method. Some of the examples of pre-processing methodologies are:

1.To ensure that the image coordinate system is correct, resampling is done.

2. Various find of filters are applied to eliminate noise which is introduced due to sensors.

3. Contrast is enhanced to correct the intensity levels at various points.

4. Techniques like gamma correction are applied[2].

Pre – Processing and Enhancement

These techniques improves the detection of the suspicious region from Magnetic Resonance Image (MRI). It basically uses the differential intensity at each point - based method which is based on the first derivative and local statistics.

3.1 Segmentation

Image segmentation is one of the important step in image analysis. It basically used to extract the entire required area which is to be analyzed and thus after extracting the required area further steps makes work little easy to monitor the tumor section following method can be used to do which are as follows.

3.1.1 Canny Method:

This method is not like other traditional edge detection methods. It has some special features like, it not only detect the edge, but it also used to suppress the noise in the image. So, it just like, it is not just masking into the input image matrix but also doing some computation to get better result.

3.1.2 Otsu Method:

The Otsu method is one of the segmentation methods, which used to do the segmentation with respect to the division in classes. So here, we need to first check the intensity threshold so that this threshold value, will help us to separate into two classes mainly the foreground and the background. So, that threshold value is determined by minimizing inter class intensity variance, or we can also get a threshold value by maximizing the inter class variance [4].

3.2 Feature Extraction/Selection

Here some of feature of the image are extracted mainly texture based feature are taken into consideration like entropy, energy, correlation etc. in case of feature selection out of whole lot features, few are selected based on certain criteria/conditions, these selected features are then used further in classification step and helps to classify the type of tumor, methods like genetic algorithm, others optimization algorithms can be used.

3.2.1 Discrete Wavelet Transform:

It is used in image denoising and image compression using 2D discrete wavelet transform, the images were decomposed into spatial frequency components and since (high-low) sub bands has more performance rate so it is preferred over (low-low) sub bands[4].

3.2.2 Principal Component Analysis:

It is used technique in image compression due to its user friendly and easy to use nature it has vast application , so it can be easily be used in the area of segmentation . It basically computes Eigen vectors of the covariance matrix and the image can be obtained by projecting the image into Eigen space and obtain corresponding set of weights which can easily be used to find required compress image[8].

CHAPTER 4

GENERIC METAHEURISTIC ALGORITHM

This chapter discusses provides an insight on generic algorithm which is followed by almost every Metaheuristic Technique.

Generic Metaheuristic Algorithm

Algorithm: General Metaheuristic Structure
Require: PP, CP, SP, UP, EP, N (≥ 1), α ($\leq$ N), β, γ ($\leq$ N)
1: Initialize counter with value(z=0)
2: Define finite number of solution Xp
3: Assess every member in solution Xp
4: identify finest solution in Xp as Sp.
5: reiterate the above steps
6: Pick α solutions (Pp) from Xp using Preference plan (PP)
7: Create β solutions (Ct) from Pp using Creation plan (CP)
8: Pick γ solutions (Rp) from Xp using Substitution plan (SP)
9: Upgrade Xp by Substituting Rp taking γ solutions from
Pp, Cp, and Rp using upgrade plan (UP)
10: Assess every member of Xp
11: Identify finest solution in Xp and update Sp
12: p$\leftarrow$ p + 1
13: Continue till end plan(EP) is satisfy
14: Identify the best fit solution as S*p

Require statement states the requirement of plans namely Preference Plan (PP), Creation Plan (CC), Upgrade Plan (UP), Substitution Plan (SP), End Plan (EP) along with the parameters like N, α, β, γ, meanwhile the individual plans may involve the different parameters depending upon their algorithm. The different steps of the general metaheuristic algorithm can be explained as follows:

Step1: Setting the counter value to zero to find the best solution need by a loop to operate with the help of a counter.

Step2: Finite no. of solutions Xp are generated randomly between the limits set by a user or algorithm. These solutions generated according to the problem-specific or application-specific, in some cases if already defined values are present then they could be directly taken from the source.

Step3: Assessing each member of Xp by using a certain objective and limit function, each member is needed to follow the constraint to remain in the solution.

Step4: After identifying the constraint member, the next step is to identify the finest solution from the set and marked as Sp, each member is first used in the certain objective function and then a pairwise comparison is done, if both feasible then choose the one with best fit value or the one which is satisfying the user set criteria.

Step5: This step is to repeat the following steps until it finds out the termination condition or the end plan met, this is done to find out the best fit solution.

Step6: Pick α solution Pp using preference plan which is very important in meta-heuristic algorithm to find the best solution. Each algorithm has a unique preference plan which is followed to find a solution.

Step7: A Creation plan is used and population is created based upon search operation, these plans vary according to the particular metaheuristic technique.

Step8: Pick γ worst solution Rp using Substituting plan to remove the worst solutions from the solution set, substituting plan is also application-specific, the term worst can be good to other algorithms.

Step9: Upgrade Set, hereafter removing worst solutions from any of the set namely Ct, Pp, Rp, Xp is upgraded.

Step10: Here again evaluation of each member of Xp is done.

Step11: The finest Solution in Xp set is identified and marked as Sp.

Step12: The counter value has incremented.

Step13: Continue until the end plan gets reached. This end plan is also application-specific as discussed above.

Step14: Finally the best fit solution is chosen.

This is the general algorithm followed by almost every metaheuristic algorithm, to find the best solution. From these techniques Preference Plan (PP), Creation Plan (CC), Upgrade Plan(UP), Substitution Plan(SP), End Plan(EP) can be analyzed along with the parameters like N, α, β, γ, etc. depending upon the techniques used.

Techniques And Working Principles

This section gives an insight of various techniques based on Generic Metaheuristic algorithm along with their working principles.

4.1 Ant Colony Optimization (ACO)

ACO is under classification category of Swarm Intelligence. It is invented by Italian scholar M. Dorgio. It is based upon the observation of real ant behaviour and how they are choosing an optimal path to find their food sources, they move from one place to another and meanwhile depositing a chemical substance named pheromone in their path, pheromone has a property of depletion with time so after been deposited in a line, it needs to be put again and again in their path so that the group remains in a line does not gets lost in between and ant can able to remain in the dedicated path . It could happen several times that these ants would not able to find pheromone, in such cases; they follow the random direction in search of the food and deposit these substances in the path [16]. Such nature of finding food by following a short/long path helps to find the optimal solution; this nature of ant is used by researchers to find various optimization solutions.

4.2 Artificial Bee Colony Optimization (ABC)

ABC is under classification category of Swarm Intelligence It is first suggested by karaboga, it depends on bee's forging their food in a different direction here food source need to be found with having, highest nectar content is the objective function of problem so the nature

of bee is to find the best solution that is considered as Artificial Bee Colony Optimization [17].The bees are divided into following three categories:-

Employed bees: it has a work to locate food and store in memory along with finding new sources in its neighborhood.

Onlooker bees: it selects the best food source from employed bees with the highest nectar content and keeps in its memory.

Scout bees: When employed bees unable to update their food location so again they follow the path randomly and searches for good food content. For every food source, the number of scout bees is generally one.

4.3.Bat Algorithm (BA)

BA is under classification category of Swarm Intelligence. It uses the process of echolocation to detect the prey, here a bat use sound waves which have different frequencies and velocities to locate its prey. The sound wave can be modified amplitude-wise or pulse emission rate until the optimization solution met [18].

4.4.Cuckoo Search (CS)

CS is under classification category of Swarm Intelligence. The algorithm states that a Cuckoo bird use ley flight method to lay an egg into a randomly selected host nest. It does not have its own nest so it depends upon the host bird's nests to have its eggs. If in the worst case the host detects the egg, then it can either throw away or abandon its nest, finding the best nest and the nest will not get destroyed is the best-optimized solution from this algorithm [19].

4.5.Differential Evolution (DE)

DE is under classification category of Evolutionary Algorithm. It is proposed by ‘Storm and Price’ a Stochastic Population-based technique, in which the formation of the chromosome followed by recombination after mutation. Here, the target vector is set which is converted into a donor vector using mutation; this donor vector is further recombined to form a trial

vector [20].The trial vector helps to find out better solutions to the particular problem. In process of choosing a better solution using trial and target vector, the greedy selection method is used. So, the optimized solution is generated in the end.

4.6.Firefly Algorithm (FA)

FA is under classification category of Swarm Intelligence. It is a soft computing technique; this algorithm captures the behavior of Firefly, produce short and rhythmic flashes. This process of producing flashlights is called bioluminescence, which helps them to find their food /partner. The intensity of light is inversely proportional to distance square, which finds the best path to achieve its optimization, it can be simply achieved by the efficiency of flashing light [21].

4.7.Genetic Algorithm Optimization (GA)

GA is under classification category of Evolutionary algorithm. Introduced in 1975, one of the widely used meta-heuristic techniques, it basically mutates the biological process of a living organism its algorithm can be discussed as follows firstly random population is generated from its random population, then tournament selection is done to choose mating pool (parents), third, the crossover process is done between the parents to produce offspring these offspring mutates again to produce offspring, this produce offspring is the best fit solution [22].

4.8.Grey Wolf Optimization (GW)

GW is under classification category of Swarm Intelligence.They are the basic style of wolf hunting the wolf has peculiar nature of hunting in a pack, this pack also has some divisions like the first is an Alpha group- it consists of the wolf who is leading their packs, they are decision-makers. The second is the Beta group- they have the responsibility to maintain discipline and see that everybody is following the Alpha group. The third is the Delta group- they are smaller in rank and mainly consists of hunters, sentinels, scout, etc. fourth is the Omega group- they are space goats and usually get to eat in the end. Wolf hunt follows procedures like encircling its prey, hunting attacking the prey till it stops, then again go to

exploration i.e. search for prey, this is how it is used to find its prey or we can say optimized solution[23].

4.9.Harmonic Search (HS)

HS is under classification category of Evolutionary algorithm. The algorithm states the nature of skilled musicians and sees their adaptive nature in improvising. There are mainly 4 factors that define HS are i) adjusting memory size ii) setting memory considering rate iii) setting pitch rate iv) defining certain stopping criteria. Here pitch can be taken just like fitness function which helps to determine the optimization quality [24].

4.10.Krill Heard (KH)

KH is under classification category of Swarm Intelligence.It is one of the algorithms which use the herding behavior of krill, mainly the factors which define the nature of krill optimization are the movement of krill other than this factor like its weight, no of runs, speed, etc. the motive is to maximize these factors to get the best solution out of this [25].

4.11. Level Set (LS)

LS are under classification category of Non-living intelligence. This method tells methods to monitor different shapes especially the shapes with different structures the algorithm depends upon 2 factors firstly to find out the position where the interface should be inserted so to get proper brain tumor contour and secondly the speed of the interface is also mattered to find the accurate region[26].

4.12.Monkey Search Optimization (MS)

MS is under classification category of Swarm Intelligence.

The monkey search algorithm shows the traits of monkey and how it is used to find their food the process shows that how they “climb” a tree can be considered as a local optimizer, watch and jump is an exchange of fitness landscape information and final trait of somersault enables exploration of new regions which in short helps to find out the best optimization solution [27].

4.13.Particle Swarm Optimization (PSO)

PSO is under classification category of Swarm Intelligence. It is based upon the population of flying insects called a swarm, every swarm as a particular position vector and velocity vector associated with it. There is predefined personal best (pbest) and global best (gbest), p-best is local and consider the best solution, so for every particle in a swarm topology, these things are informed previously. So the particle follows a certain updating rule w.r.t position and velocity and in the end, tries to converge towards the gbest solution [28].

4.14.Simulated Annealing (SA)

SA is under classification category of Non-living Intelligence. It states the process of formation of a crystal, so basically, the formation of a crystal involves the process of cooling the metal, slowly to make a proper crystal from it. the convergence function follows Boltzmann Probability Distribution, the algorithm begins with an initial point at high temperature secondly the difference in energy is calculated to check the solution at updated temperature if smaller function value then points is accepted otherwise discarded this process now carries for more iteration or just n iterations and sufficient low-temperature point we get[29].

4.15.Water Cycle (WC)

WC is under classification category of Nonliving Intelligence. The algorithm basically uses nature's water cycle and sees how they are being used to give the optimization result. The algorithm consists of different stages namely i) Precipitation- this process can be linked to random initialization of population, ii) Percolation into the sea this can be linked to that population is meant to be attracted towards the best solution, iii) Evaporation, followed by precipitation – this step can be linked to the stage where reinitialization of the same solution is done. So this is how it be used to find the best solution [30].

CHAPTER 5

SEGMENTATION

This chapter discusses the main concepts of the segmentation and different techniques of segmentation that is used in the project.

5.1 Canny Algorithm

This method is not like other traditional edge detection methods. It has some special features like, it not only detect the edge, but it also used to suppress the noise in the image. So, it just like, it is not just masking into the input image matrix but also doing some computation to get better result. Let us understand the Canny Edge detection method through steps. The first step of Canny Edge detection method is that it will convert the input colored image into a grayscale image . Here, the sample image is taken from the input. And we need to convert the RGB image into grayscale image. The next step is gaussian blur : which is helps in removing the noise from the input image. So, it using an operator, which helps in processing the image and makes it to be smooth and flawless. For this we also need to assign a particular sigma value, which can be set, accurately, for the better result.

the third step is intensity gradient calculation: here, we need to use some of the basic filters to do this process. We are mainly using sobel filter, which detects the certain intensity change in the edge. And in fact, it also detect the intensity change of the pixels around the edge . Here, mainly the gradient magnitude of the image is being compared to get the intensity gradient calculation. Here we are using sobel operator because, here, it is basically using gradient operator helps to find the threshold value , this threshold value can be used to detect the edge in the image. The Fourth step is non maximum suppression, here the gradient, what we have calculated in Sobel edge detection method is being used. So, here what we have done in the previous image is to detect the edge, which is, which is detecting normally detect, our thick edges but in the final image we should expect it to have thin edges. So this process of non maximum suppression should be followed to drive the thin edges from the thicker one. So let us understand this further. We have the edge direction already available with us and in this step we need to relate the identify edge direction to the

direction that can be sketched in the image. That is, ideally, we need to identify the movement of the edges. For example, lets take a three into three matrix as a reference. It's all about the colors and the Visualizing this three to three matrix. For this scenario we need to analyze the image matrix from north to south, from east to west, and to the both the diagonals. Out of all cell, center cell is basically our region of interest. So, before going to understanding the region, we should be knowing the whole four possible direction for any fixture, which could be 0 degree, 45 degree , 90 degree and 135 degree.

So, to focus, two forces that were our edge has to be definitely oriented to one of the four direction. This is kind of approximation where, if the orientation angle is observed to be five degrees variation , then it is taken as zero degree or suppose if it is 43 degrees we can consider it to be as a 45 degree. So for ease of understanding. We can have a semicircle with color shading. This would be representing all the degrees, mainly in that semi circle. So, what we are doing by drawing this semicircle is that any edge, which comes under the following color range is set to that particular degree. So for example, if we are being selecting for colors, namely, yellow, green, red, or blue. And we are defining red color to be 135 degree, blue color to be 90 degree and green color to be 45 degree. So here, if we are getting any edge, which is in the range of zero to 22.5 degree, or we can say, from 150 7.5 to 180 degree will assign a yellow color. Similarly, for an edge, which is to be set to 45 degree. Which means 22.5 to 67.5 degrees is said to be a 45 degree, and we will assign a green color similarly, the blue is in ranges 67.5 degree to 112 point five degrees. And the last one. that is the red range is 135 is from 112 point five degree to 150 7.5 degrees. After this process mainly what the direction of edges is to be mapped to any of these four direction which we have mentioned above. So, what is the last step, it comes here is that the edge direction. we need to determine the edge direction in the last step : the non maximum suppression is also being applied. So here the suppression of the pixels, zero, which cannot be considered as an edge is carried out. So this cell. This will help to generate the line or the thin edge from an image. So here we have detected in our image, and another step, which we usually follow is update of thresholding and smoothing. So, after doing thresholding. The thresholding steps

That it provides an excellent result, So if there is some noise left out of the detecting image is being cured by using a threshold. let us understand how this thresholding is being done. let

us assume a high threshold value to be. For suppose 0.9 So any pixel which is above 0.9 is to be taken as a stronger edge, any value and let us assume as 0.2 to be a lower edge limit, and if any value is lower than the 0.2 is to be considered as the to be lighter edge. So now comes the portions, is that in between 0.2 to 0.9. They may or may not be any edge. The six step is the edge tracking. So here we need to understand that, which of the edges are the courageous, or the actual edges. So simple approach has to be followed, we can call the weak edges connected to strong edge as the strong edge, and retain them and weak edge which are not connected to stronger ones are to be removed. And the last step is, of data cleaning here, where the weak edges are removed, and to get the final output results.

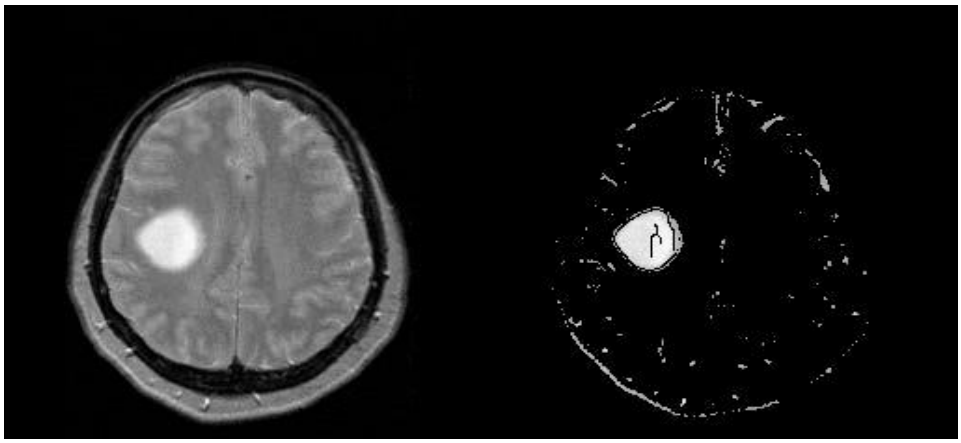


Fig. 3: Output from Canny Algorithm

5.2 Otsu Algorithm:

The Otsu method is one of the segmentation methods, which used to do the segmentation with respect to the division in classes. So here, we need to first check the intensity threshold so that this threshold value, will help us to separate into two classes mainly the foreground and the background. So, that threshold value is determined by minimizing inter class intensity variance, or we can also get a threshold value by maximizing the inter class variance. It is somewhat related to other methods like Fisher discriminant analysis , also it is related to global optimal k means method, which is an extension to multi level thresholding

respect to a single level. Look, there are some steps , we follow in the algorithm. The steps are , first we need to compute the histogram and then we need to find the probabilities, related to it. The second step is set up Class probability and mean. Now we need to find the maximum intensity or the minimum intensity and accordingly we need to update the mean and the probability associated with the class. Then further step in this is, is computing inter class variance, after computing the class variance, according to the desired value . Threshold value corresponding to the minimum class variance, or the maximum class.

This method has some limitation also for the good performance we have to assume that it has bio model distribution. The object area should not be small in comparison to the background area and secondly we need to also check that the variance between a variance. Difference between object, and the background should not be large. If this will happen then, what the problem is that, we got some additive noise in between and which will not be able to get the desired result. So though there might be a possibility that the result what we are getting from otsu method is not accurate . there can be some improvements in this methods like instead of one dimensional, we can try for the two dimensional method, which in a way performs better segmentation tasks. In case of noisy images. And it also able to find the better result with respect to the average immediate neighborhood to improve your segmentation.

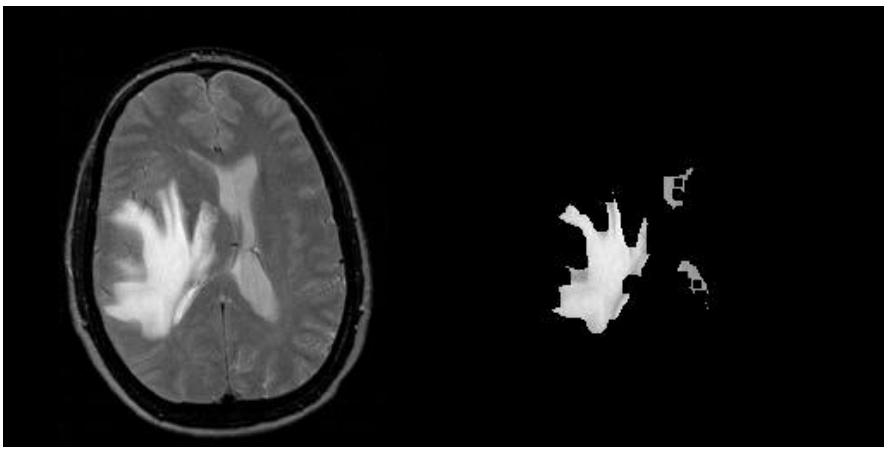


Fig.4 : Output from Otsu Algorithm

CHAPTER 6

FEATURE EXTRACTION

This chapter discusses the main concepts of feature mainly texture features and how it is extracted and used in our project.

They are the most important characteristics of the object of interest. If features are selected then they help in providing relevant information regarding the classification problem. They given as to the classifiers which helps to determine them to particular class they relate to. It is to reduce the database and take only relevant information into consideration which can differentiate among one class to another class.

Here we are mainly focusing on the texture based features. They are very useful in identifying the diseased brain images. Such features are calculated using gray level co-occurrence matrices (GLCM).

6.1 GRAY LEVEL CO-OCCURRENCE MATRIX

The statistics is classified as first order, seconder order and higher, according to pixel values at various points in the image. This approach has applications like, eg. Image classification, terrain classification, sandstone reservoir classification, object detection, segmentation of images, GLCM concept is proposed by Haralick in 1970s. It is basically a representation of pixel value associated to particular in the foam of table for a particular image. The elements of matrix that is $P(k, l/\Delta x, \Delta y)$ is basically the frequency with which two neighboring pixels, one at intensity level *k,* and other at intensity level *l*, are separated by a distance of $(\Delta x, \Delta y)$. Similarly the second order statistics of GLCM matrix can be represented by $P(k, l/d, \theta)$, where the pixels values *k* and *l* are separated by a distance *d* at a particular angle θ.

Let us consider an image having a Ax B neighborhood and 'g' gray levels ranging between 0 and 'g-1'. Let *f(a,b)* be the intensity at pixel a and line b of the neighborhood[4].

$$P(k, l/\Delta x, \Delta y) = WQ(k, l/\Delta x, \Delta y)$$

where

$$W = \frac{1}{(A - \Delta x)(B - \Delta y)}$$

and

$$Q(k, l/\Delta x, \Delta y) = \sum_{n=1}^{N-\Delta y} \sum_{m=1}^{M-\Delta x} F$$

$$F = 1 \; if \; f(m, n) = i \; and \; f(m + \Delta x, n + \Delta y) = j$$

$$F = 0 \; elsewhere$$

A 5x5 image with four different levels and its co-occurrence matrix $P(k, l/\Delta x, \Delta y)$ is shown below:

IMAGE

0 1 1 2 3
0 0 2 3 3
0 1 2 2 3
1 2 3 2 2
2 2 3 3 2

GRAY LEVEL IMAGE HAVING 4 INTENSITY LEVELS

P(i,j;1,0)

	j=0	1	2	3
i= 0	1/20	2/20	1/20	0
1	0	1/20	3/20	0
2	0	0	3/20	5/20
3	0	0	2/20	2/20

FIG. 5 : GLCM MATRIX OF THE IMAGE ABOVE

6.2 TEXTURE FEATURES FROM GLCM

There are different features calculated from GLCM matrix (Haralick el al. 1973, Conners el al. 1984). The following notations are used:

μ is the mean value of P.

$\mu_x, \mu_y, \sigma_x, \sigma_y$ are the mean and standard deviations of P_x *and* P_y.

$$P_x(k) = \sum_{l=0}^{g-1} P(k,l)$$

$$P_y(l) = \sum_{k=0}^{g-1} P(k,l)$$

$$\mu_x = \sum_{k=0}^{g-1} k \sum_{l=0}^{g-1} P(k,l) = \sum_{k=0}^{g-1} kP_x(k)$$

$$\mu_y = \sum_{k=0}^{g-1} \sum_{l=0}^{g-1} lP(k,l) = \sum_{l=0}^{g-1} lP_y(l)$$

$$\sigma_x^2 = \sum_{k=0}^{g-1}(k-\mu_x)^2 \sum_{l=0}^{g-1} P(k,l) = \sum_{k=0}^{g-1}(P_x(k)-\mu_x(l))^2$$

$$\sigma_y^2 = \sum_{l=0}^{G-1}(l-\mu_y)^2 \sum_{k=0}^{G-1} P(k,l) = \sum_{k=0}^{G-1}(P_y(k)-\mu_y(k))^2$$

EXAMPLES OF TEXTURE FEATURES

Texture can be categorized as: **visual and touch texture**. Touch texture relates to the feel when we touch any surface and it range from smoothest to roughest. While visual texture is related to visual perception, when we see any object and the changes occur due to color, brightness, intensity and orientation of an image. According to the GLCM matric, fourteen texture features are introduced by Haralick, which define the texture characteristics of the images. In this thesis work ten of these texture features are being used and are explained below:

6.2.1 ENTROPY

Entropy is one of the texture feature of the image which defines the randomness of the images. Images which are having in homogeneous scenes are having low value of first order entropy and those having homogeneous scenes are having high value of first order entropy. It is calculated using the

formula:

$$ENTROPY = -\sum_{k=0}^{g-1}\sum_{l=0}^{g-1} P(k,l) * \log(P(k,j))$$

Direct matlab function is also available for calculating entropy, that is, “entropy(I)”. The entropy of image can be calculated from the graphical interpretation of the image. This representation helps to calculates various gray level probabilities and used in the prediction of entropy.

Entropy is highest with equal probabilities in P(k,l) and lower with unequal entries in P(k,l) .

6.2.2 CORRELATION

Correlation is a statistical measure of linear dependency of neighboring pixels at particular locations with respect to each other.

$$CORRELATION = \sum_{k=0}^{g-1}\sum_{l=0}^{g-1}\frac{\{k \times l\} \times P(k,l) - \{\mu_x \times \mu_y\}}{\sigma_x \times \sigma_y}$$

The range of values of the coefficient lies between -1 and 1. If its value is 1, then it indicates that the variables are positively closely related and if -1, it indicates negatively closely related. But if the value is zero it shows a very weak relationship between the variables.

6.2.3 VARIANCE

Variance is the measures the dispersion of values of the pixels , this dispersion can be with respect to neighboring pixel. It gives higher weights to the points which differ largely from the mean value. It is calculated using the formula:

$$VARIANCE = \sum_{k=0}^{g-1}\sum_{l=0}^{g-1}(k-\mu)^2\, P(k,l)$$

6.2.4 CLUSTER SHADE

Cluster shade is based on the skewness of the GLCM matrix. It is based upon the concept of symmetry and uniformity. If an image found to be symmetric then the value will be low and if an image is not symmetric then the value will be high. It is calculated using the formula given below:

$$CLUSTER\ SHADE = \sum_{k=0}^{g-1}\sum_{l=0}^{g-1}(k+l-\mu_x-\mu_y)^3 \times P(k,l)$$

6.2.5 CLUSTER PROMINENCE

Similar to cluster shade, cluster prominence is also a parameter for the measure of asymmetry. When the value of prominence is high image is said to be less symmetric, when the value of prominence is low it is more symmetric. The high value of cluster prominence states that, there exists a peak around the mean value in the GLCM matrix. It is calculated using the formula given below:

$$CLUSTER\ PROMINENCE = \sum_{k=0}^{g-1}\sum_{l=0}^{g-1}(k + l - \mu_x - \mu_y)^4 \times P(k,l)$$

6.2.6 ANGULAR SECOND MOMENT

Angular second moment (ASM) is a helps to measure the homogeneity in the image. It tells about the uniformity in the image. Its value is large when the pixels in the image are very similar. It is calculated using the formula:

$$ASM = \sum_{k=0}^{g-1}\sum_{l=0}^{g-1}\{P(k,l)\}^2$$

6.2.7 INERTIA

Inertia is the statistical measure of the rotation inertia of the rigid bodies in the image. It represents how much effort is required to rotate an image, if each pixel intensity is associated with a weighted mass. The higher is the pixel value at a point, the more is the weighted mass value and the harder it is to rotate that point. The colored images are first converted at gray scale for the calculation of the statistical measure. Inertia is calculated using the formula below:

$$INERTIA = \sum_{k=0}^{g-1}\sum_{l=0}^{g-1}(k - l)^2 \times P(k,l)$$

6.2.8 ENERGY

Energy is basically the measure of extent to which pixel pairs are repeating. By this the uniformity of image is being measured. The value of energy will be large when there will be too much similarity among the pixels. Energy is calculated using the formula given below:

$$ENERGY = \sqrt{\sum_{k=0}^{g-1}\sum_{l=0}^{g-1} P(k,l)^2}$$

6.2.9 INVERSE DIFFERENCE MOMENT

Inverse difference moment (IDM) it is known to measure the homogeneity of the image the ting is that its region is local based. The closeness of the GLCM matrix elements to its diagonal elements is measured by the IDM function. By the range of values of IDM function we can know about the texture of an image. IDM function is calculated using the function:

$$IDM = \sum_{k=0}^{g-1}\sum_{l=0}^{g-1} \frac{1}{1+(k-l)^2} P(k,l)$$

6.2.10 CONTRAST

Contrast used to measures the difference in color and brightness among two objects. In this context contrast is basically the difference of the intensity values among various point in the image.

$$CONTRAST = \sum_{n=0}^{g-1} n^2 \left\{ \sum_{k=0}^{g-1}\sum_{l=0}^{g-1} P(k,l) \right\}, \qquad |k-l| = n$$

CHAPTER 7

FEATURE SELECTION

In machine learning traditional algorithms can handle the data with a large number of instances but as soon as the dimensionality of the data keeps on increasing the complexity of the algorithms increases. The solution to this problem is to find which dimensionality is important and which are not. Evolutionary algorithms are being used for this process of dimensionality reduction.

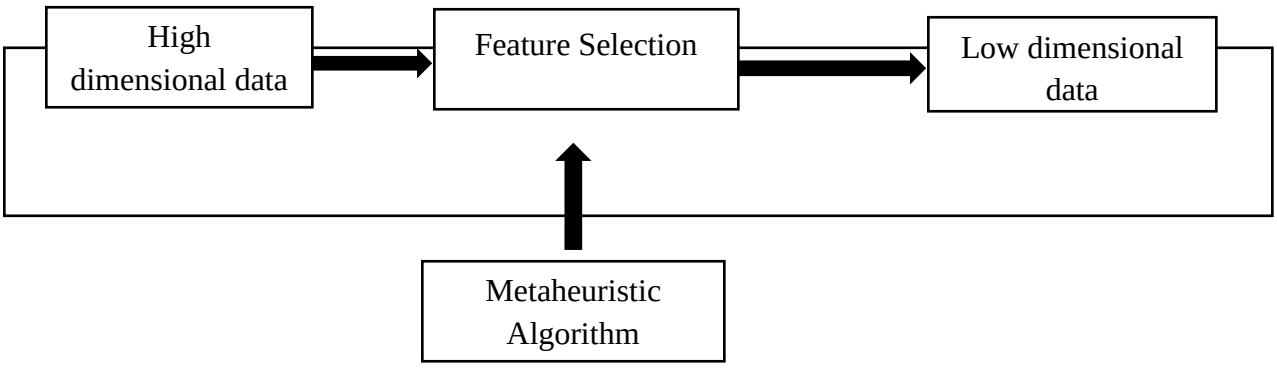


FIG 6: GENERAL APPROACH OF FEATURE SELECTION

There are commonly three reasons because of which feature selection is used:

i. To simplify the classifications problems so that their interpretation becomes easier.
ii. So as to limit the training time of classifiers.
iii. Over fitting is prohibited to some extent by this method.

7.1 FITNESS FUNCTION

Fitness function is basically an objective function which is used to define how close the designed solutions are to the desired results. The fitness function is useful in selecting the best feature subset among the whole search space of features. We keep on iterating the loop until the maximum number of generations have occurred or the stopping criterion is satisfied and this will give us the best feature set.

The choice of fitness function is basically application dependent. It depends on what quantity we want to maximize or minimize. In this thesis, fitness function which is being used is given by the

$$finess\ function = (Accuracy + Sensitivity + Specificity) + (0.05 \times number)$$

equation shown below:

The first three parameters, that is, accuracy, sensitivity and specificity are basically the performance parameters which are being used in every classification problem to know the performance of the classification.

$$Accuracy(\%) = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Sensitivity(\%) = \frac{TP}{TP + FN}$$

$$Specificity(\%) = \frac{TN}{TN + FP}$$

Where

TP: True positive

TN: True negative

FP: False positive

FN: False negative

7.2 PARAMETERS USED

Accuracy gives the amount of correct detected result with respect to the total results which are produced while doing the process.

Sensitivity gives the amount of positive test samples classified with respect to the total of correct positive and incorrect negative result classified.

Specificity gives the proportion of total negative test samples that are classified with respect to correct negative and incorrect positive result classified.

The features which are extracted are represented in the form of binary strings of zeros and ones. To find a feature subset, in binary string the 0s represents that the feature is excluded and 1s represent that the feature is included. So here in the fitness function formula the quantity number represents the total number of 0s in the binary string. We have to look for the maximum value of this fitness function for different feature sets and the formula used will help in this task.

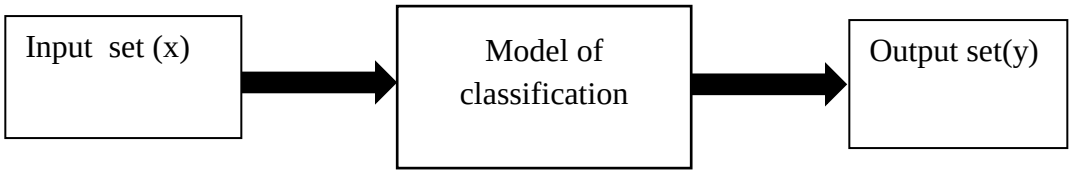
The sum of the performance parameters accuracy, sensitivity and specificity increases as the classification performance increases with the search space of features and will tend to move the value of fitness function to a more positive side. Same thing is done by the parameter number, as the number of zeros increases in the binary string that means less number of features are considered, fitness function value increases. So the aim of this fitness function is to get high classification performance with less number of features.

CHAPTER 8

CLASSIFICATION

This chapter discusses the classification methods used in the project and see the effect of different kernel function.

The method of classification helps to identify a new observation to a particular group or classes. The process contains the two set basically test set and train set ,train set is a training set which contains set according to the observation whose class label is known and similarly test set is used to verify the result with train set. In terms of machine learning, classification belongs to supervised learning methods. Any algorithm that do classification is a classifier. It refers to the mathematical function, where input data is mapped into a category[8]. Linear classifier include perceptron, logistic regression naive baye's classifier and many more. Classification algorithms are widely used in many fields and in our application of detecting brain tumor it is one of the essential step to get the final output.



Classification Model

Classification methods are basically of two types: Supervised and Unsupervised classification.

i. **Supervised Method:** In case of supervised learning we already have a set of training sample and their target values and inferred to that a function is created which helps in finding target values for the test samples.
ii. **Unsupervised Method:** In this method target value is not known. Techniques are used to analyze the images and the pixels which are closely related are assigned to the same class.

SVM CLASSIFIER

SVM has become popular for its wide use in the fields of pattern recognition and regression in previous years. It belongs to supervised learning methods which run by analyzing data and recognizing patterns. Given a set of training examples with known class labels, SVM develop a model which assigns new examples a class label based on patterns that are recognized. It is a supervised algorithm which required test set to determine the nature of the actual detected set. It can also be used in nonlinear classification. The working of SVM depends on the formation of hyperplane according to the criteria define. Basically, a good classification is done by the plane that covers maximum margin as it reduces the generalization error.

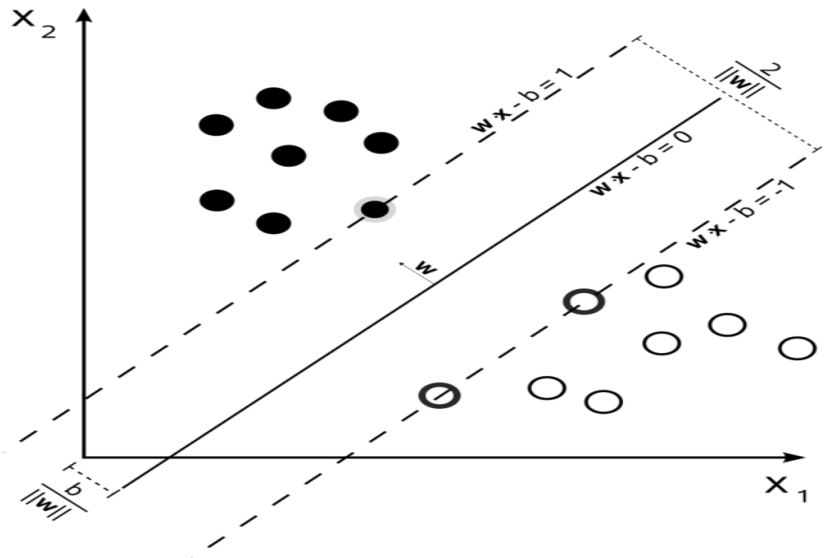


FIG. 7 SVM CLASSIFIER

A set of n points comprising training data d where output can be 1 or -1 which indicates the class to point x belongs. Any hyper-plane can be represented as the set of points x that satisfy equation:

$$w.x - b = 0$$

denotes the dot product and w is the normal vector to hyper-plane.

Two hyper-planes that separate data are selected if the training data is linearly separable. Then the distance between them called margin is maximized. Hyper-planes are represented as:

$$w.x - b = 1$$

and

$$w.x - b = -1$$

It can be rewritten as:

$$y_i(w.x_i - b) \geq 1, \quad \text{for all } 1 \leq i \leq n$$

The maximum margin classifier, which is the standard SVM, is found by maximizing the margin and is equivalent to the following problem

Minimize

$$min_{(w,b)} \quad \frac{1}{2}\|w\|^2$$

subject to $y_i(w.x_i - b) \geq 1$ for all $1 \leq i \leq n$

8.1 Kernel function

In SVM classifier there are cases where there is nonlinear classification. To define the nonlinear classification. We want some more detail model then what we are using that model are called kernel model. This model for function can be used to classify nonlinear data set.

So, why we need kernel model let us understand this with an example. Suppose there are distributed balls , distributive balls looks like a red one and blue one they are arranged in random fashion then one question arises that how to classify these ball, we need on nonlinear hyperplane. So instead of having a straight line hyperplane we are need a nonlinear type hyperplane. So this is the main use of the kernel function, where it has the nonlinear type of hyperplane.

There are different types of kernel function exists we are tried to discuss some of them here.

Define kernel or a window function as follows:

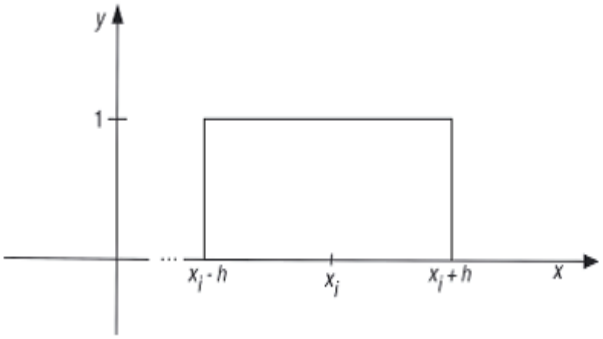
$$K\left(\overline{x}\right) = \begin{matrix} 1 & \text{if} \left\|\overline{x}\right\| \le 1 \\ 0 & \text{otherwise} \end{matrix}$$

Kernel or a window function

This value of this function is 1 inside the closed ball of radius 1 centered at the origin, and 0 otherwise .

Kernel or a window function

For a fixed xi, the function is K(z-xi)/h) = 1 inside the closed ball of radius h centered at xi, and 0 otherwise as shown in the figure below:



Kernel or a window function

So, by choosing the argument of K(·), you have moved the window to be centered at the point xi and to be of radius h.

8.1.1 Different SVM Kernels

They are as follows:

8.1.2 Polynomial kernel

Equation is:

$$k(\mathbf{x_i}, \mathbf{x_j}) = (\mathbf{x_i} \cdot \mathbf{x_j} + 1)^d$$

Polynomial kernel equation

where d is the degree of the polynomial.

8.1.3 Gaussian kernel

Here knowledge of prior data is not known:

$$k(x, y) = \exp\left(-\frac{\|x - y\|^2}{2\sigma^2}\right)$$

8.1.4 Gaussian radial basis function (RBF)

General kernel and most used kernel of the above category Equation is:

for: $\gamma > 0$

$$k(\mathbf{x_i}, \mathbf{x_j}) = \exp(-\gamma \|\mathbf{x_i} - \mathbf{x_j}\|^2)$$

Gaussian radial basis function (RBF)

CHAPTER 9
SOFTWARE-DESIGN

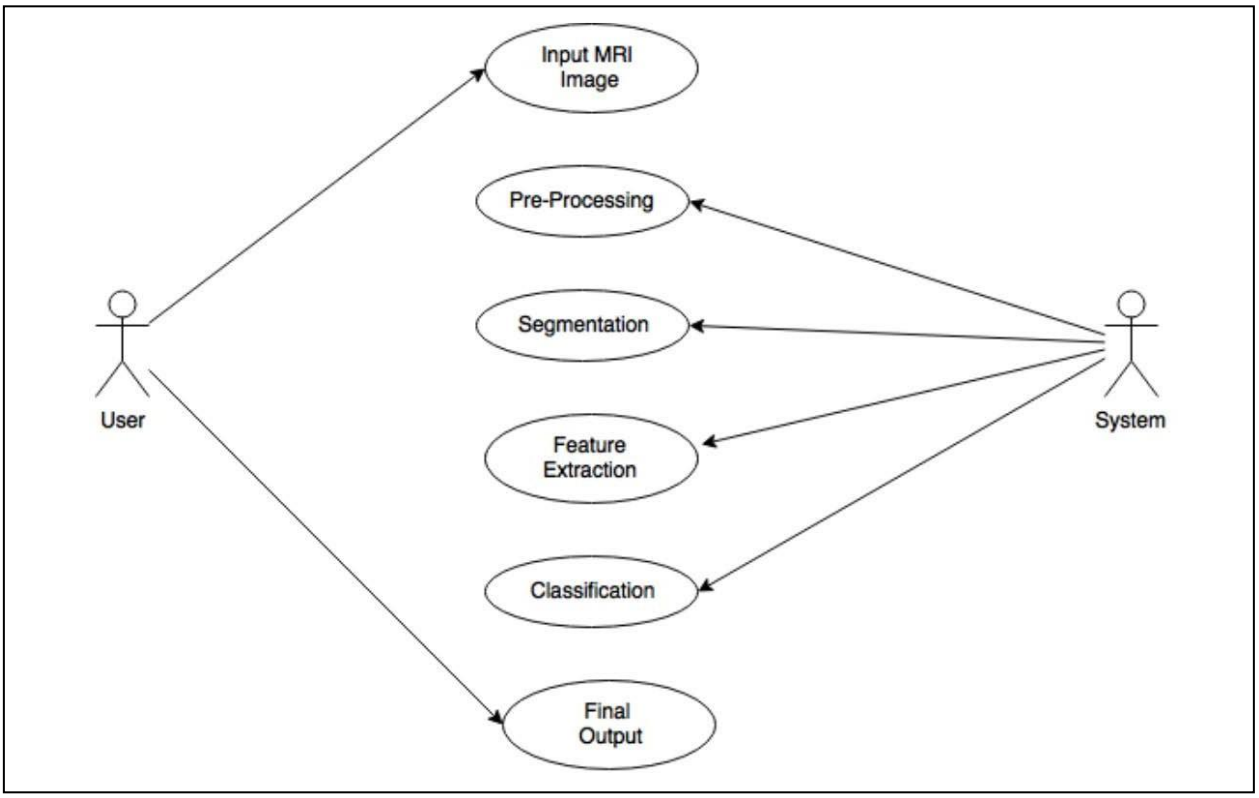


Fig 8. Case diagram

- The use case diagram consists of two actors, who interact with the software.
- The User: The user takes in input image and sees the final output
- The System: The System performs all clustering, feature extraction, classification and training algorithms.

Class Diagram

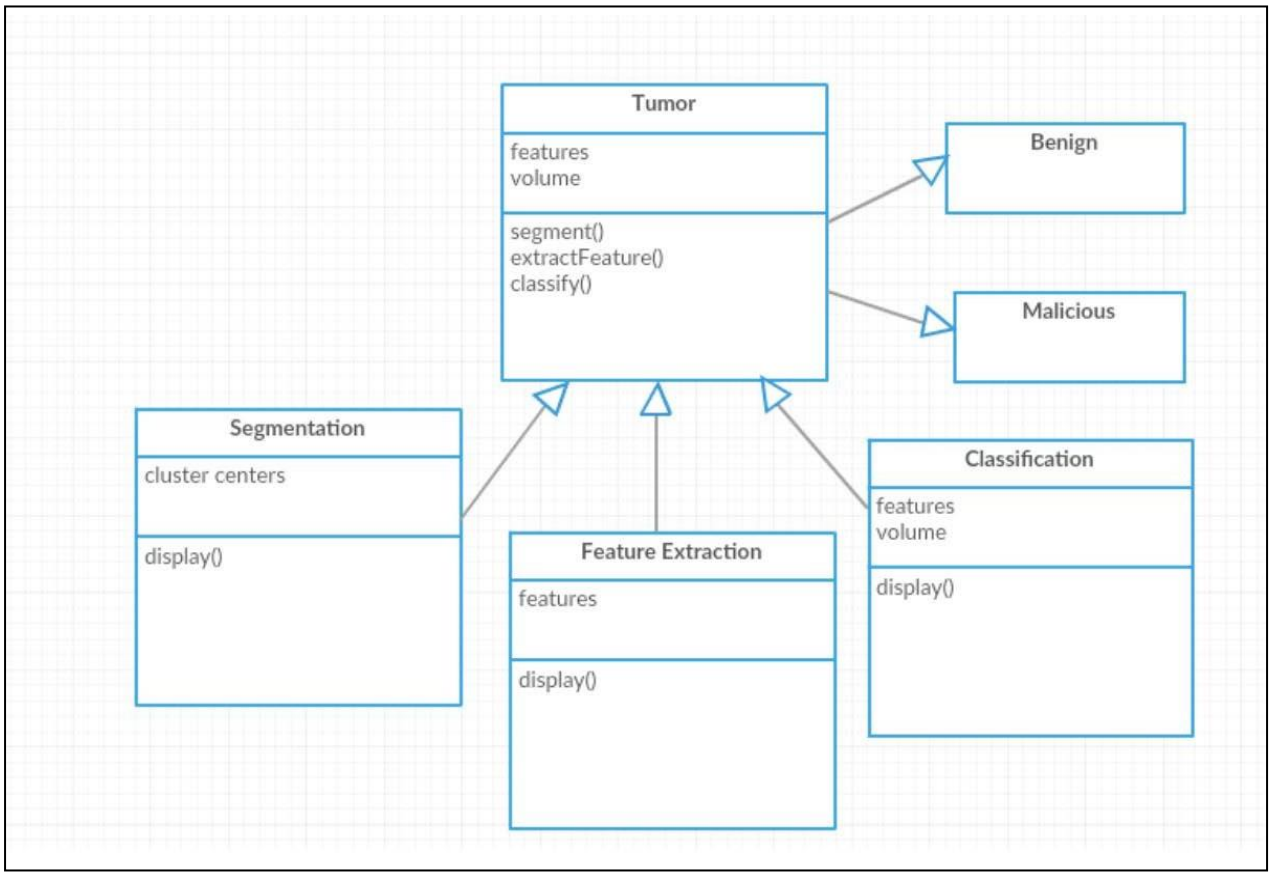


Fig. 9: Class Diagram

CHAPTER 10

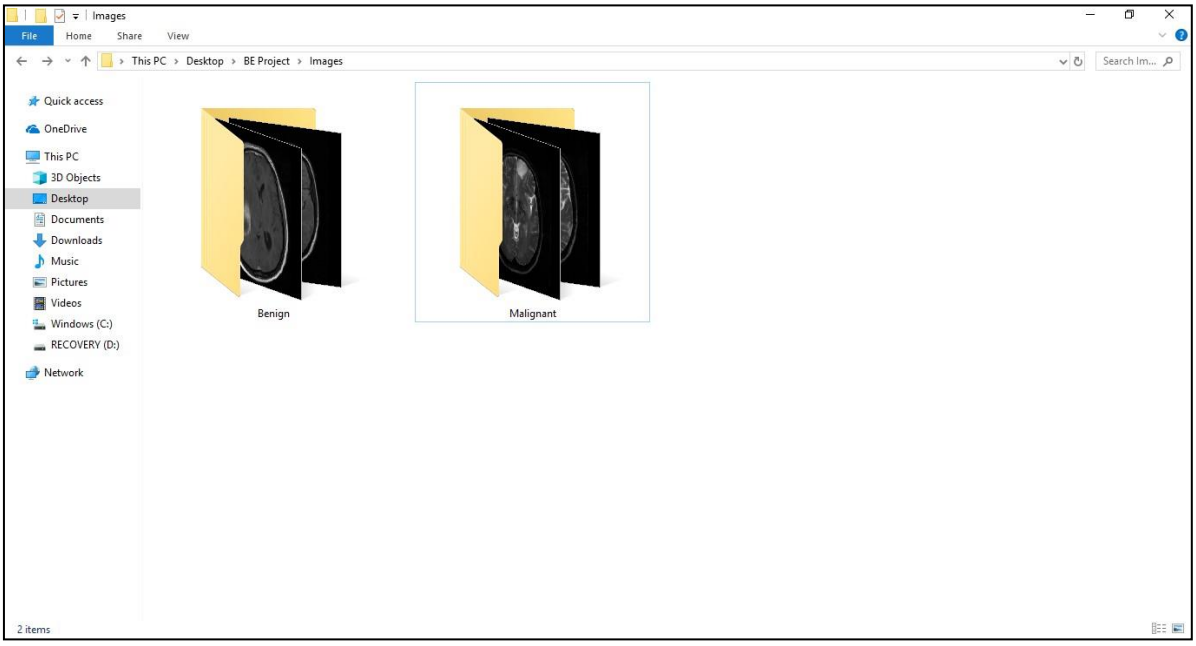
RESULT

This chapter carries the results of our project. The result discuss here covers the detection and classification of brain MR image along with the accuracies and feature extracted values.

Dataset Used for Analysis

Data was collected from various verified sources and then segregated into two types:

- Cancerous (Malignant)
- Non-cancerous (Benign)



Segregated Dataset

Proposed Techniques result in two cases :

CASE 1: TUMOR IS IN MALIGNANT STAGE

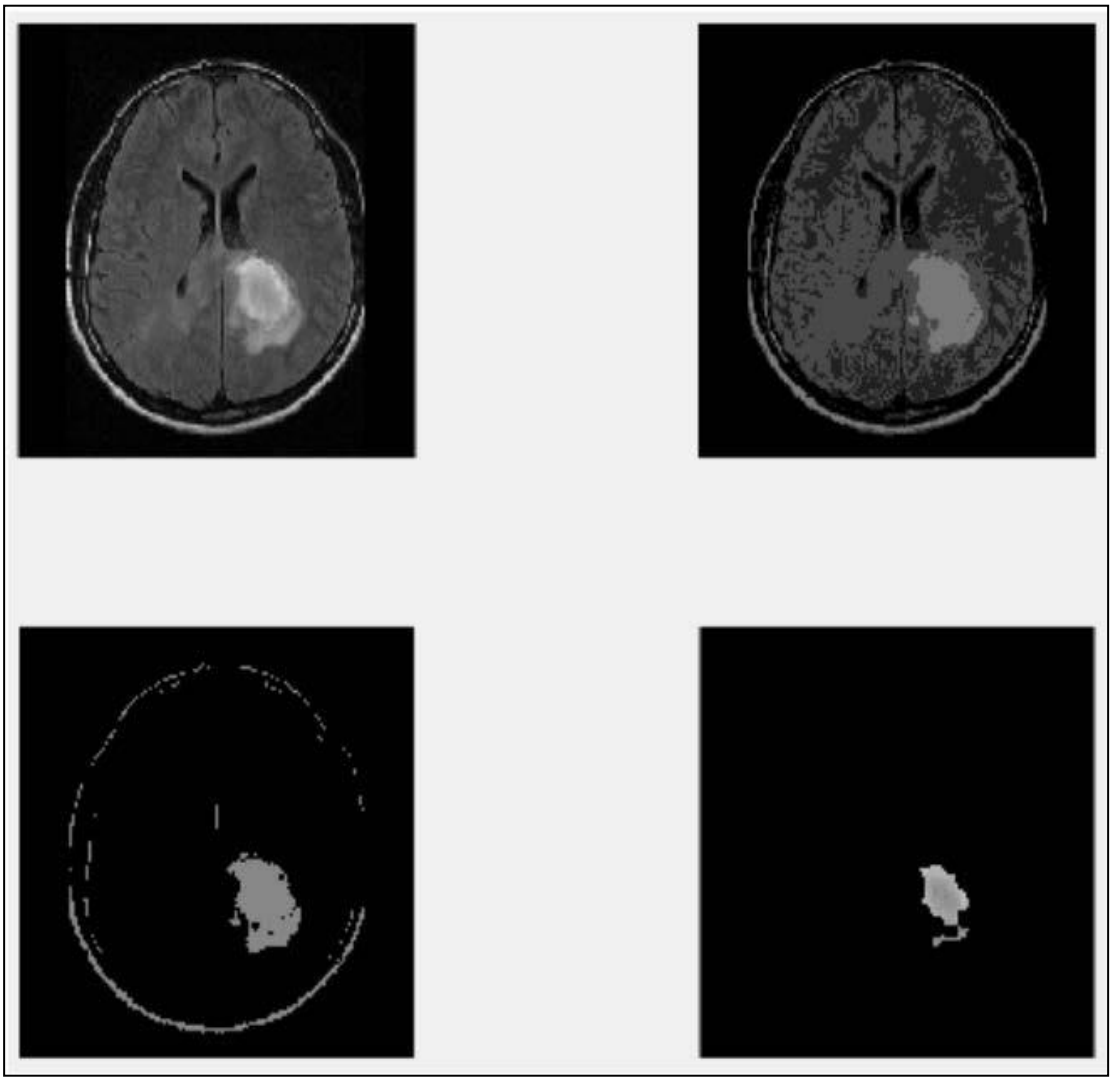


Fig. 10 : Output from Proposed Algorithm (Malignant)

CASE 2: TUMOR IS IN BENIGN STAGE

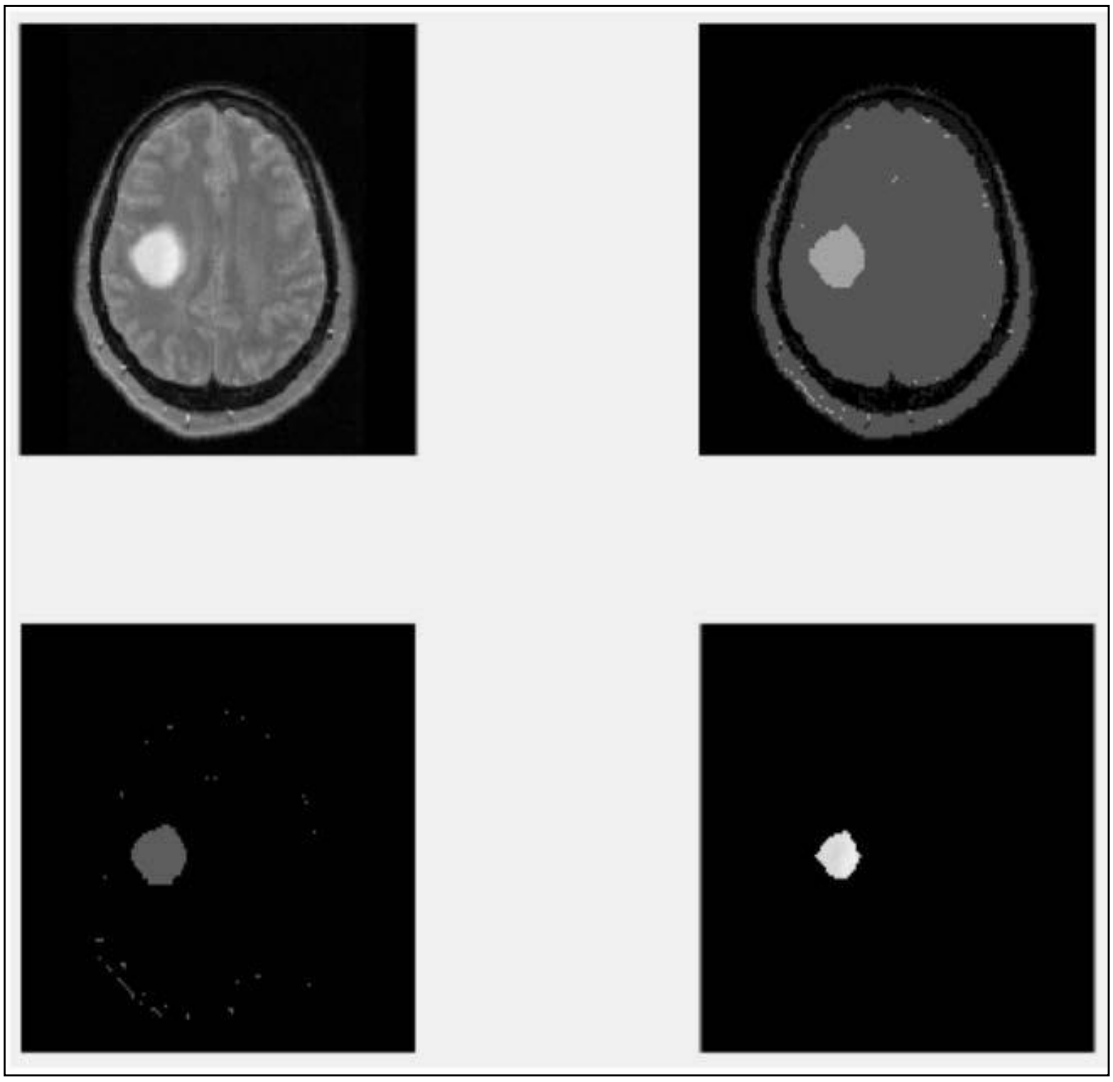


Fig. 11 : Output from Proposed Algorithm (Benign)

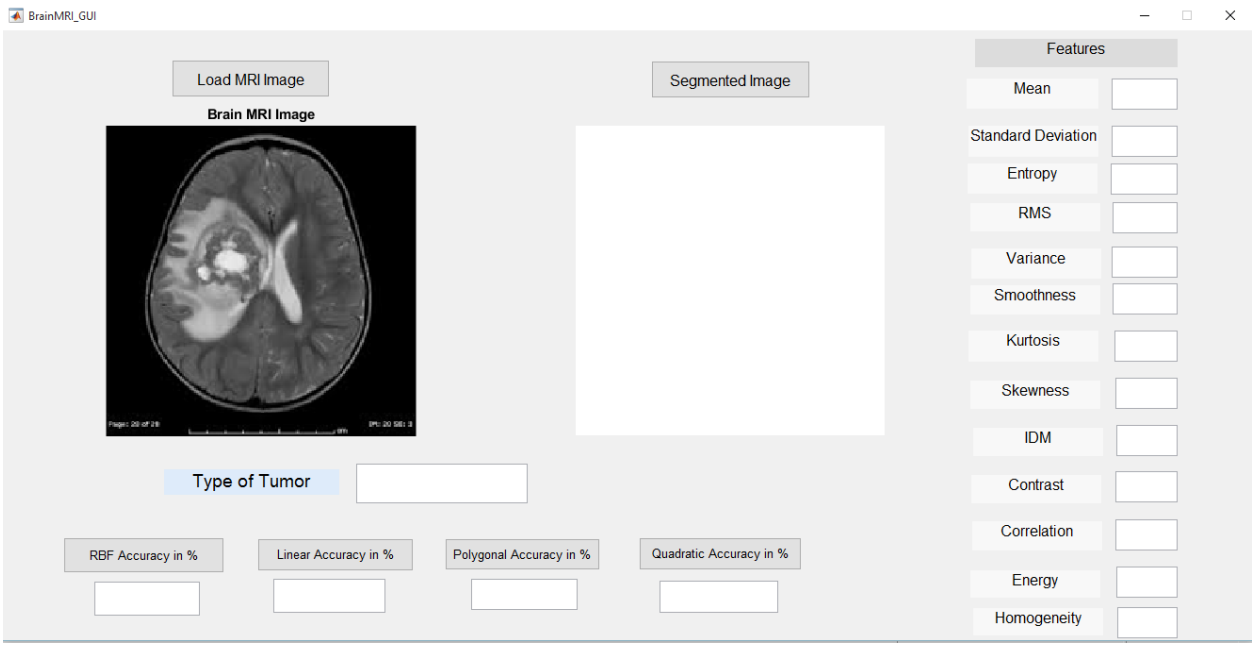


Fig 12 : loading the brain MR images

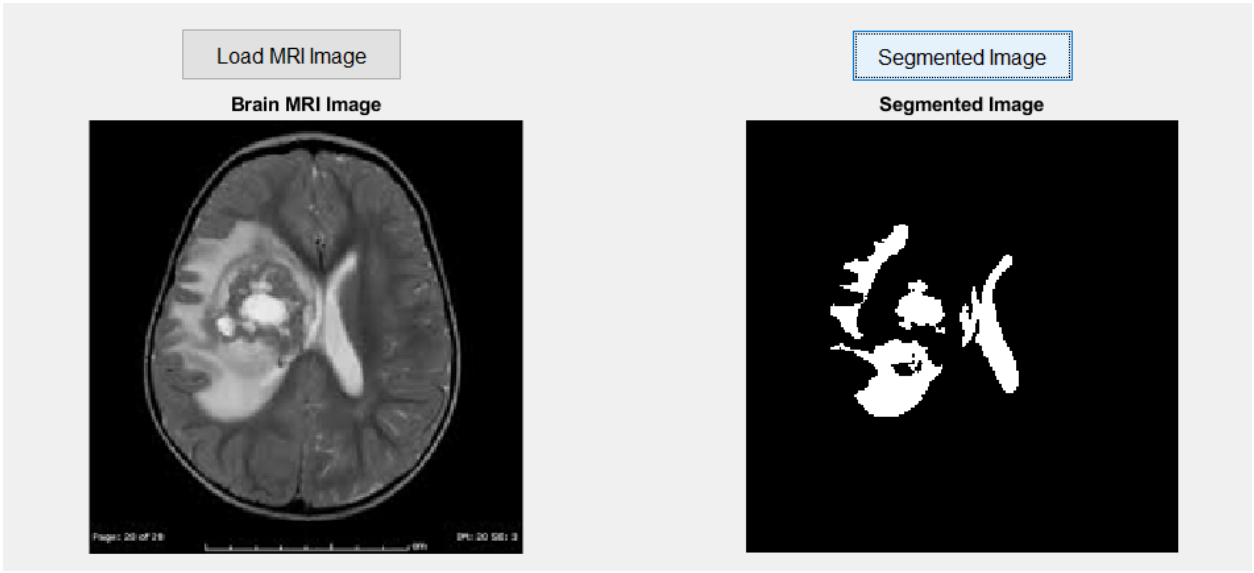


Fig. 13: Segmented Image

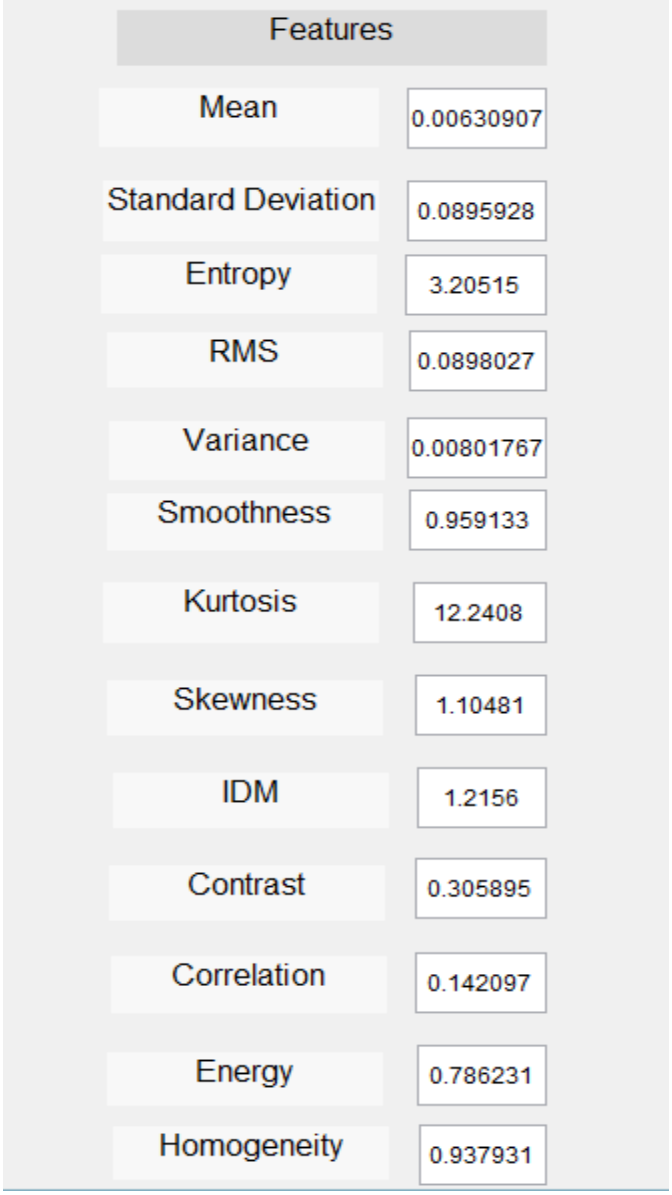


Fig. 14: Features of extraction

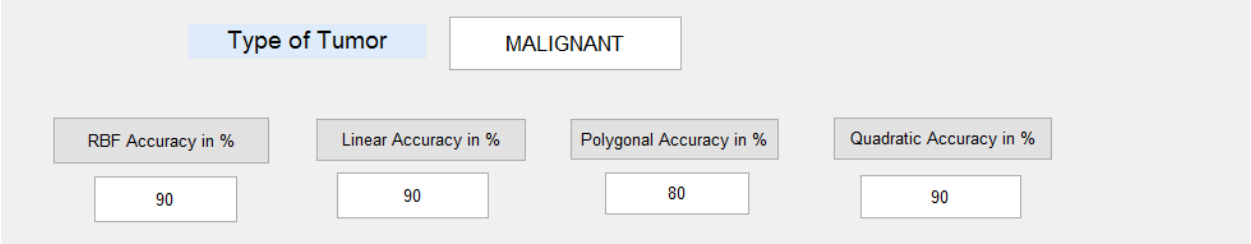


Fig. 15: Type of tumor and Accuracy

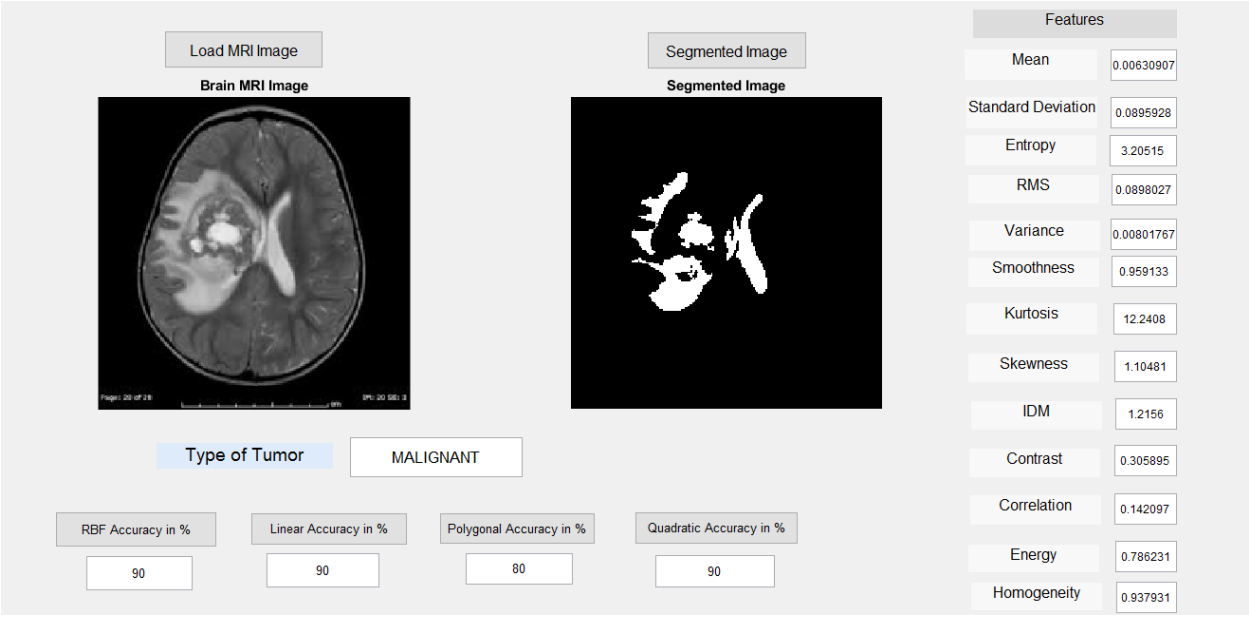


Fig. 16: Complete Detection and classification in one figure

Parameters	Without using optimization technique(%)	With using optimization technique(%)
RBF Accuracy	85	90
Linear Accuracy	87	90
Polynomial Accuracy	82	80
Quadratic Accuracy	87	90

Table: Performance classification of the system with and without optimization technique

10.1 Component Diagram

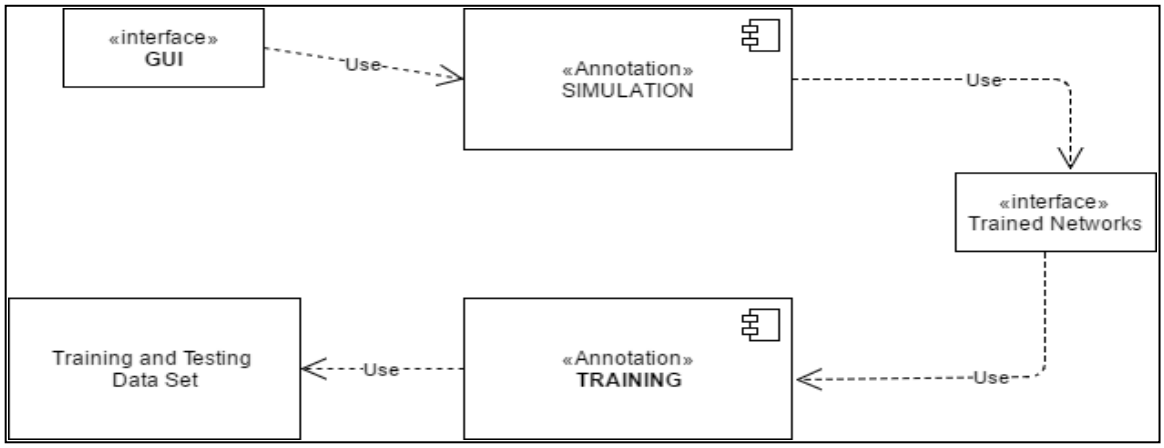


Fig. 17 : Component Diagram

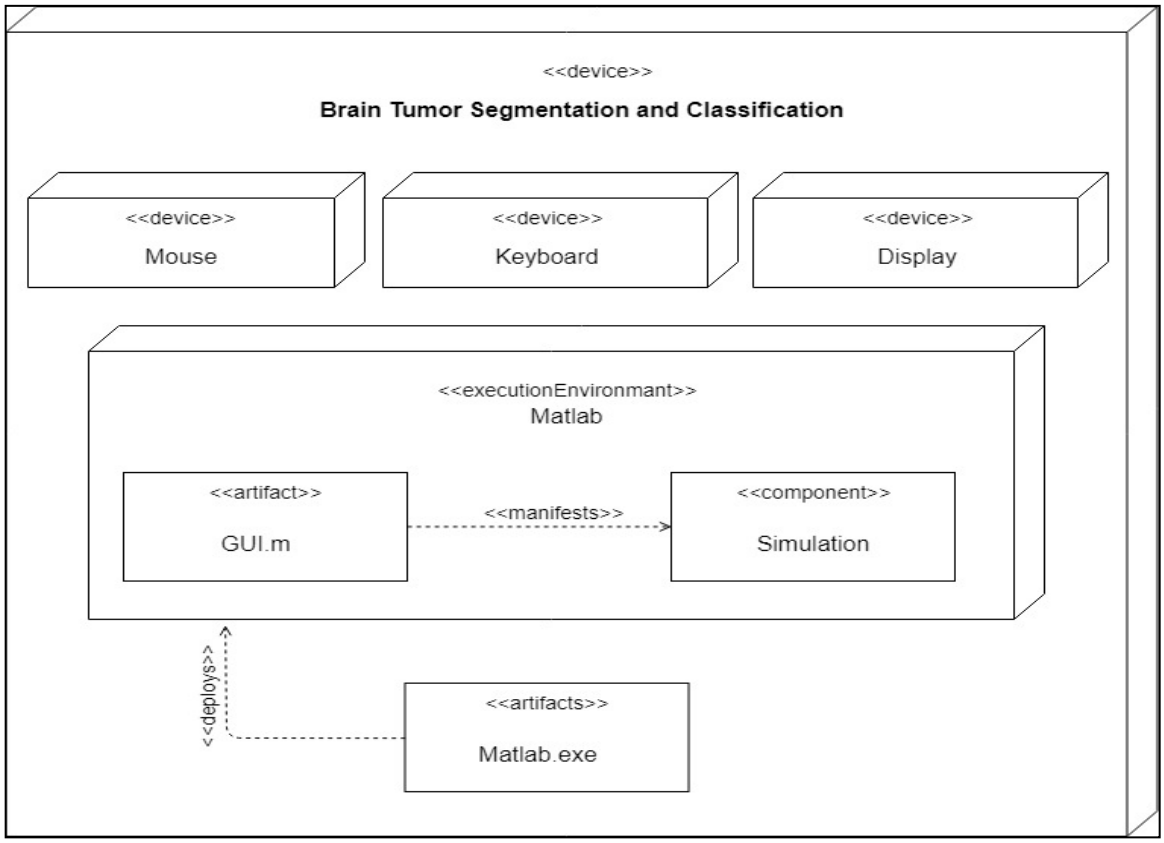


Fig. 18 : Deployment Diagram

CHAPTER 11

CONCLUSION AND FUTURE SCOPE

This chapter discusses the lessons learned and the knowledge gained after the completion of our project and the possible future scope of our project.

11.1 Conclusion

It can be concluded that the algorithms and the parameters used in the proposed system are all meant to increase the efficiency of the system by achieving better results.
The Severity of a Brain Tumor, depends upon its detection stage, if detected in its initial stage, most Brain Tumors are curable and having more survival rate than usual. This thesis gives a review of the Metaheuristic Optimization-based CAD system which helps in better detection of brain tumors. It provides the study of popularly used Metaheuristic techniques which are used in detecting brain tumor from Brain MRI. However, there is still research going on to develop faster and accurate CAD system as these methods have some limitations which can be removed. Hence the detailed knowledge of Metaheuristic Optimization Techniques, their advantages and recent studies in the field of brain tumor detection will help to develop an improved CAD system that provides aid to doctors and assist them to give an accurate detection result.

The boundary approach and the edge based approach for segmentation are very common but the region growing approach gives better results. It is found that the particle swarm optimization algorithm gives the most accurately segmented tumors. Features extracted by using GLCM method help to increase efficiency as minute details of tumor by using various features can be extracted. Of the various classification methods studied, it was experimentally found that the convolution neural networks give the best classification accuracy. Accuracy and reliability are of utmost importance in tumor diagnosis, as a patient's life depends on the results predicted by the system. Thus, the proposed methodology helps in increasing the accuracy and obtaining the desired results.

11.2 Future Scope

We need to make efficient prototype for the neurosurgeon and cardiologist which they can user friendly and tries to give more accurate result. So in this field we try by using different classification and segmentation algorithm and also we can use feature extraction algorithm to get better result.

It is discussed that Metaheuristic Optimization algorithms are widely used in complex optimization problems, along with various studies that these algorithms has some limitation like their these algorithm has less mathematical nature ,which makes it difficult to derive exact theory behind them. It is also observed that some algorithm which are developed in recent years has some similarity between them like harmony search algorithm has similarity with evolutionary algorithm strategy etc. which leads to developments of unnecessary new algorithms. So there is a need of future research which helps to rectify the problem of mathematical analysis and novelty of different algorithms, thesis tried to provide an generic framewok which relates and fits these metaheuristic algorithms under one framework, the same can tried to be done in future research by providing the general framework of these types of algorithm.

References

[1] H. Emrah, O. Celal, and K. Dervis, “Extractıon of Braın Tumors from MRI Images wıth Artıfıcıal Bee Colony based Segmentatıon Methodology,” pp. 516–520.

[2] M. Lee, S. Kim, W. Cho, S. Park, and J. Lim, “Segmentation of Brain MR Images using an Ant Colony Optimization Algorithm,” pp. 4–7, 2009, doi: 10.1109/BIBE.2009.58.

[3] I. Conference and I. Engineeringst, “Contrast Enhanced Brain Tumor Segmentationbased on Shannon’s Entropy and Active Contour,” no. March, pp. 16–18, 2017.

[4] E. Ben George, “Brain Tumor Segmentation using Cuckoo Search Optimization for Magnetic Resonance Images,” pp. 1–4, 2015.

[5] M. Ramadas, “Detecting tumours by segmenting MRI images using transformed differential evolution algorithm with Kapur ’ s thresholding,” *Neural Comput. Appl.*, vol. 0, 2019, doi: 10.1007/s00521-019-04104-0.

[6] M. P. S. Deshpande and P. S. J. Honade, “Brain Tumor Segmentation and Detection using Firefly Algorithm,” vol. 12, no. 2, pp. 129–144, 2017, doi: 10.9790/2834-120203129144.

[7] A. Halder, A. Pradhan, S. K. Dutta, and P. Bhattacharya, “Tumor extraction from MRI images using dynamic genetic algorithm based image segmentation and morphological operation,” *Int. Conf. Commun. Signal Process. ICCSP 2016*, pp. 1845–1849, 2016, doi: 10.1109/ICCSP.2016.7754489.

[8] T. Attar and T. Bhattacharjee, “Parametric Optimization of Logarithmic Transformation using GWO for Enhancement and Denoising of MRI Images.”

[9] O. Moh and R. Mandava, “A hybrid harmony search algorithm for MRI brain segmentation,” pp. 31–49, 2011, doi: 10.1007/s12065-011-0048-1.

[10] J. Preethi, “A Bio Inspired Hybrid Krill Herd-Extreme Learning Machine Network Based On Lbp And Glcm For Brain Cancer Tissue Taxonomy,” 2018, doi: 10.1109/ICCIA.2018.00033.

[11] D. Algorithm, “SS symmetry 3D-MRI Brain Tumor Detection Model Using Modified Version of Level Set Segmentation Based on Dragonfly Algorithm,” 2020.

[12] S. Alagarsamy, T. Abitha, S. Ajitha, S. Sangeetha, and V. Govindaraj, “Identification of high grade and low grade tumors in MR brain image using modified monkey search algorithm,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 993, no. 1, 2020, doi: 10.1088/1757-899X/993/1/012052.

[13] A. Dixit and A. Nanda, “Brain MR Image Classification via PSO based Segmentation,” *2019 12th Int. Conf. Contemp. Comput. IC3 2019*, pp. 7–11, 2019, doi: 10.1109/IC3.2019.8844883.

[14] M. Ben Ayed, A. Kharrat, and M. Ben Halima, “MRI Brain Tumor Classification using

Support Vector Machines and Meta-Heuristic Method," pp. 446–451.

[15] N. Ara, H. Kaur, and A. Devi, "Novel Approach of Brain Tumor Segmentation Using Convolutional Neural Network Hybridized with Water Cycle Algorithm," no. July, pp. 3733–3738, 2020.

[16] C. Ratanavilisagul, "Modified Ant Colony Optimization with pheromone mutation for travelling salesman problem," *ECTI-CON 2017 - 2017 14th Int. Conf. Electr. Eng. Comput. Telecommun. Inf. Technol.*, pp. 411–414, 2017, doi: 10.1109/ECTICon.2017.8096261.

[17] N. Pathak, M. Mishra, and S. P. S. Kushwah, "Improved local search based modified ABC algorithm for TSP problem," *Proc. 2017 4th Int. Conf. Electron. Commun. Syst. ICECS 2017*, vol. 17, pp. 173–178, 2017, doi: 10.1109/ECS.2017.8067863.

[18] A. M. Alhassan, W. A. N. Mohd, and N. Wan, "BAT Algorithm With fuzzy C-Ordered Means (BAFCOM) Clustering Segmentation and Enhanced Capsule Networks (ECN) for Brain Cancer MRI Images Classification," vol. 8, pp. 201741–201751, 2020, doi: 10.1109/ACCESS.2020.3035803.

[19] C. Zefan and Y. Xiaodong, "Cuckoo search algorithm with deep search," *2017 3rd IEEE Int. Conf. Comput. Commun. ICCC 2017*, vol. 2018-Janua, pp. 2241–2246, 2018, doi: 10.1109/CompComm.2017.8322934.

[20] O. Tarkhaneh and H. Shen, "An adaptive differential evolution algorithm to optimal multi-level thresholding for MRI brain image segmentation," *Expert Syst. Appl.*, vol. 138, p. 112820, 2019, doi: 10.1016/j.eswa.2019.07.037.

[21] S. K. Sarangi, R. Panda, S. Priyadarshini, and A. Sarangi, "A new modified firefly algorithm for function optimization," *Int. Conf. Electr. Electron. Optim. Tech. ICEEOT 2016*, pp. 2944–2949, 2016, doi: 10.1109/ICEEOT.2016.7755239.

[22] G. Brain and A. The, "Hybrid Genetic and Variational Expectation-Maximization Algorithm for," *IEEE Trans. Inf. Technol. Biomed.*, vol. 15, no. 3, pp. 373–380, 2011.

[23] P. Idziak, K. Kowalski, L. Nowak, and L. Knypiński, "FE transient analysis of the magnetostrictive actuator," *Int. J. Appl. Electromagn. Mech.*, vol. 51, no. s1, pp. S81–S87, 2016, doi: 10.3233/JAE-2011.

[24] J. Wei, W. Jing, W. Wei, C. Liulin, and J. Qibing, "A parallel harmony search algorithm with dynamic harmony-memory size," *2013 25th Chinese Control Decis. Conf. CCDC 2013*, pp. 2342–2347, 2013, doi: 10.1109/CCDC.2013.6561329.

[25] A. H. Gandomi and A. H. Alavi, "Krill herd: A new bio-inspired optimization algorithm," *Commun. Nonlinear Sci. Numer. Simul.*, vol. 17, no. 12, pp. 4831–4845, 2012, doi: 10.1016/j.cnsns.2012.05.010.

[26] P. Sudharshan Duth, V. P. Saikrishnan, and V. P. Vipuldas, "Variational level set and level set method for mri brain image segmentation: A review," *Proc. 2017 IEEE Int. Conf. Commun. Signal Process. ICCSP 2017*, vol. 2018-Janua, pp. 1555–1558, 2018, doi: 10.1109/ICCSP.2017.8286649.

[27] S. Mittal, K. Gopal, and S. L. Maskara, “A novel Bayesian Belief Network structure learning algorithm based on bio-inspired monkey search meta heuristic,” *2014 7th Int. Conf. Contemp. Comput. IC3 2014*, pp. 141–147, 2014, doi: 10.1109/IC3.2014.6897163.

[28] S. Mahapatra, M. Badi, and S. Raj, “Implementation of PSO, it’s variants and Hybrid GWO-PSO for improving Reactive Power Planning,” *2019 Glob. Conf. Adv. Technol. GCAT 2019*, no. 1, pp. 1–6, 2019, doi: 10.1109/GCAT47503.2019.8978348.

[29] C. H. Onwiese and R. Omel, “and C -D. S ¨ ¨ S,” vol. 14, no. 3, pp. 1–11, 2005.

[30] S. Khalilpourazari and M. Mohammadi, “Optimization of closed-loop Supply chain network design: A Water Cycle Algorithm approach,” *Proc. 12th Int. Conf. Ind. Eng. ICIE 2016*, no. Icie, pp. 41–45, 2016, doi: 10.1109/INDUSENG.2016.7519347.