A Minor Project Report on

Brain Tumor Segmentation with Deep Neural Networks

Submitted by

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Under the guidance of

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In partial fulfilment of the award of Bachelor of Technology in Computer Science and Engineering

Department of Computer Science and Engineering,

Maharashtra Institute of Technology Aurangabad, (M.S)

[2021-22]

DECLARATION

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included; I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Place: Aurangabad

Date:

Signature and Name of Students

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2) **Somesh Kharat (53)**

CERTIFICATE

This is to certify that the minor project report entitled "**Brain tumor segmentation with deep neural networks"**, submitted by "**Ganesh Balaji Jamkar** and **Somesh Balaji Kharat",** is the Bonafide work completed under my supervision and guidance in partial fulfilment for the award of Bachelor of Technology in Computer Science and Engineering, Maharashtra Institute of Technology under Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (M.S.).

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APPROVAL CERTIFICATE

This Minor Project report entitled "**Brain tumor segmentation with deep neural network"** by Name of candidate **"Ganesh Balaji Jamkar** and **Somesh Balaji Kharat",** is approved for Bachelor of Technology in Computer Science and Engineering, Maharashtra Institute of Technology under Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (M.S.).

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(Name)

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I would like to express my special thanks of gratitude to our project guide Ms. B.P.Chaudhari for their valuable support in completion of my project.

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Mr. Ganesh Balaji Jamkar

Mr. Somesh Balaji Kharat

ABSTRACT

Image segmentation is the process of partitioning a digital image into multiple segments. Image segmentation is used to locate objects and boundaries in images. It is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set contours extracted from the image. Each of the pixels in a region are similar with respect to some characteristics such as color, intensity, texture. Clustering algorithms groups the samples of a set such that two samples in the same cluster are more similar to one another than two samples from different clusters.

Segmentation of tumour images is one of the fundamental problems in image processing field .It aims to provide a crucial decision support to physicians. Tumor image segmentation is a prime domain of application of digital image processing. Automated identification of different regions of an image are often required by the human experts and it is several application in real life as well as this system reduces the headache of the human experts. In this work, a tumour image segmentation method is proposed which is based deep neural network.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Brain tumors are a life-threatening disease for humans. Brain tumors are uncontrollable growths of tissue or cells in or around the brain. Cells in our bodies usually develop, become weakened, and die, but this process does not occur in certain people. The new cells do not divide and the old cells remain in the body, causing the growth of more cells into a mass of tissues known as a tumor. A brain tumor is thought to be a set of rare cells framed in the brain. The brain tumor can occur at any time during one's life, but they are not all the same. A brain tumor is a mass of abnormal cells in our brain that can be divided into two types: malignant (non-destructive) and benign (destructive / harmful). Although the function of the tumor has not yet been determined, some of the reasons may serve as the basis for a brain tumor. The primary motivation for a brain tumor is ancestry. Family characteristics are responsible for about 80% of the chances of developing a brain tumor. Age, compound exposure, family ancestry, radiation exposure, and ethnicity are all risk factors for brain tumors.

A brain is the most complex organ in the human body, it's functioning still only partially known to us. So if there exists an abnormality in it, the effects of abnormality are unknown too and keep varying person to person. The most dangerous of such anomaly is a tumor. Tumor exists in two phases: - either benign or malignant. Benign kind is less harmful as they are not invasive, once removed from the body it poses no threat, while malignant kind keeps coming back and hence classified as cancerous. The only way to increase the prognosis of a patient facing tumor is to detect and classify the tumor in nascent stages. Over a period of time, manual inspection of Magnetic Resonance images was the go-to practice for detection of the tumor. In the recent year with advancement in sensory and image processing technology many works regarding detection and classification have been proposed which are based on image segmentation histogram equalization, feature selection and extraction and classification, image enhancement, and many more.

1.2 Objectives and Necessity

To develop computational methods and algorithms to analyze and quantify tumor images data.
To monitor the changes in various types of brain tumor images. To provide better image processing (object detection and segmentation) and better image quality for brain tumor iamges. Applying information analysis and visualization to brain tumor images data.To involve processing an image into fundamentals components to extract meaningful information.

1.3 Problem Definition

To show that the brain tumor detection can be successfully used to solve difficult problems in pattern recognition and image processing. To develop an efficient image segmentation based on brain tumor. To develop a tool that can aid researchers in the unsupervised image classification field to test their algorithms, compare different algorithms and generate benchmarks. To develop an efficient image analysis that can find the accuracy of brain tumor image.

1.4 Scope

Image segmentation which is complex optimization problem can be solved by this simple detection model which is formulated in this paper. The proposed algorithm randomly assigns the center of brain tumor and classify it. Not only provide the best value but also Brain tumor image segmentation is one of them that has great impact on the automated computer aided diagnostics process.Automated image segmentation has several application in real life.

1.5 Applications

The same genetic algorithm is applied to find the size and the type of calcifications in MRI brain images and are extracted in future. The possibilities of using other algorithms are also considered for further implementation. Segmentation of brain tumor images is one of the fundamental problems in image processing field. It aims to provide a crucial decision support to physicians. Brain tumor image segmentation is a prime domain of application of digital image processing. Automated identification of different regions of an image are often required by the human experts and it is several application in real life as well as this system reduces the headache of the human experts.In this work, a brain tumor image segmentation method is proposed which is based on deep neural networks.

Chapter 2

LITERATURE SURVEY

The aim of this project is to improve the segmentation using nature deep neural network techniques. Image analysis which is complex optimization problem can be solved by deep neural network which is formulated in this project. Following are the literature survey on some existing system or its advantages, drawbacks and Future scope.

The genetic algorithm belongs to the family of evolutionary algorithms, along with genetic programming, evolution strategies, and evolutionary programming. Evolutionary algorithms can be considered as a broad class of stochastic optimization techniques. An evolutionary algorithm maintains a population of candidate solutions for the problem at hand. The population is then evolved by the iterative application of a set of stochastic operators. The set of operators usually consists of mutation, recombination, and selection or something very similar. Let's discuss some of the papers published that is related to the Genetic Algorithm in the past. Here in this paper compared the results, which come after applying many different crossover and mutation operators devised for the traveling salesman problem and it is concluded that operators that use heuristic information or a matrix representation of the graph give the best results. Genetic algorithms are an evolutionary technique that uses crossover and mutation operators to solve optimization problems using a survival of the fittest idea. They have been used successfully in a variety of different problems, including the traveling salesman problem. In the traveling salesman problem the aim is to find a tour of all nodes in a weighted graph so that the total weight is minimized. The traveling salesman problem is NP-hard but has many real world applications so a good solution would be useful.

Sr. No.	Paper Title, Author, Journal/conference	Method/ Approach used	Advantages	Drawback(s)	Future Scope
1	Genetic Algorithm.MDU Rohtak	Genetic Algorithm, Crossover, operators, Mutation operators	Employed for a wide variety of optimization problems.	Premature convergence Occurs.	Function Optimizations.
2	Genetic Algorithm. IEEE Conference.	Genetic Algorithm, Inheritance, Crossover	Handles large, poorly Understood search	Definition of representation for the problem	Strategy planning.
3	Genetic algorithm: Past, present, and future	Classical Genetic Algorithm.	Easily modified for different problems.	The problem for identifying fitness Function.	TSP and sequence scheduling.
4	Brain tumor detection using DNN algorithm	Detection of brain tumor images	Classify the brain tumors	Enhancing MR images of tumor using global thresholding.	optimization method used to improve classification accuracy.

Table 2.1 Literature Survey

A. Genetic Algorithm.MDU Rohtak

Genetic Algorithms (GA's) are adaptive methods which may be used to solve search and optimization problems. They are based on the genetic processes of biological organisms. Over many generations, natural populations evolve according to the principles of natural selection and survival of the fittest, first clearly stated by Charles Darwin in The Origin of Species. By mimicking this process, genetic algorithms are able to find solutions to real world problems, if they have been suitably encoded. For example, GA's can be used to design bridge structures, for maximum strength/weight ratio, or to determine the least wasteful layout for cutting shapes from cloth. They can also be used for online process control, such as in a chemical plant, or load balancing on a multiprocessor computer system.

The combination of good characteristics from different ancestors can sometimes produce super fit offspring, whose fitness is greater than that of either parent. In this way, species evolve to become more and better suited to their environment. Genetic algorithms use a direct analogy to natural behaviour. They work with a population of individuals, each representing a possible solution to a given problem. Each individual is assigned a fitness score according to how good a solution to the problem it is. The highly fit individuals are given opportunities to reproduce, by cross breeding with other individuals in the population. This produces new individuals as offspring, which share some features taken from each parent. The least fit members of the population are less likely to get selected for reproduction, and so die out.

Literature review:

The genetic algorithm belongs to the family of evolutionary algorithms, along with genetic programming, evolution strategies, and evolutionary programming. Evolutionary algorithms can be considered as a broad class of stochastic optimization techniques. An evolutionary algorithm maintains a population of candidate solutions for the problem at hand. The population is then evolved by the iterative application of a set of stochastic operators. The set of operators usually consists of mutation, recombination, and selection or something very similar. Let's discuss some of the papers published that is related to the Genetic Algorithm in the past. Here in this paper compared the results, which come after applying many different crossover and mutation operators devised for the traveling salesman problem and it is concluded that operators that use heuristic information or a matrix representation of the graph give the best results. Genetic algorithms are an evolutionary technique that uses crossover and mutation operators to solve optimization problems using a survival of the fittest idea. They have been used successfully in a variety of different problems, including the traveling salesman problem. In the traveling salesman problem the aim is to find a tour of all nodes in a weighted graph so that the total weight is minimized. The traveling salesman problem is NP-hard but has many real world applications so a good solution would be useful

Snehal Kamalapur suggested in his paper on "Efficient CPU Scheduling: A Genetic Algorithm based Approach "that Operating system's performance and throughput are highly affected by CPU Scheduling. The scheduling is considered as an NP problem. An efficient scheduling improves system performance. In her paper she presents and evaluates a method for process scheduling. In this paper, she discussed the use of genetic algorithms to provide efficient process scheduling. And evaluate the performance and efficiency of the proposed algorithm in comparison with other deterministic algorithms and in a way that optimises some performance by simulation.

B. Brain tumor detection using DNN Algorithm:

Introduction:

Brain tumors are a life-threatening disease for humans. Brain tumors are uncontrollable growths of tissue or cells in or around the brain. Cells in our bodies usually develop, become weakened, and die, but this process does not occur in certain people. The new cells do not divide and the old cells remain in the body, causing the growth of more cells into a mass of tissues known as a tumor. A brain tumor is thought to be a set of rare cells framed in the brain. The brain tumor can occur at any time during one's life, but they are not all the same. A brain tumor is a mass of abnormal cells in our brain that can be divided into two types: malignant (non-destructive) and benign (destructive / harmful). Although the function of the tumor has not yet been determined, some of the reasons may serve as the basis for a brain tumor. The primary motivation for a brain tumor is ancestry. Family characteristics are responsible for about 80% of the chances of developing a brain tumor. Age, compound exposure, family ancestry, radiation exposure, and ethnicity are all risk factors for brain tumors.

In "Computer Aided System for Brain Tumor Detection and Segmentation "the methodology used is enhancing the MR image and segmentation of tumor using global thresholding. Using morphological operations and by applying window technique the False segmented pixels are removed. The proposed method is invariant in terms of size and shape of brain tumor. In "Brain Tumor Detection Using Deep Neural Network and Machine Learning Algorithm" paper, an entirely different methodise used based on the combination of CNN for tumor detection and feature extraction algorithm from brain images.In "Brain Tumor Detection and Classification Using Deep Learning Classifier on MRI Images" paper, classification of tumoris done by multiple kernel-based probabilistic clustering and also by using deep learning classifier.In "Binarized Neural Networks" a new method of BNNs is introduced, which binarizes the deep neural networks and can lead to dramatic improvements in consumption of power and speed.In "Brain Tumor Detection based on Machine Learning Algorithms" paper proposes a work on brain tumor detection system based on machine learning algorithms. The texture based features are extracted using Gray Level Co-occurrence Matrix.

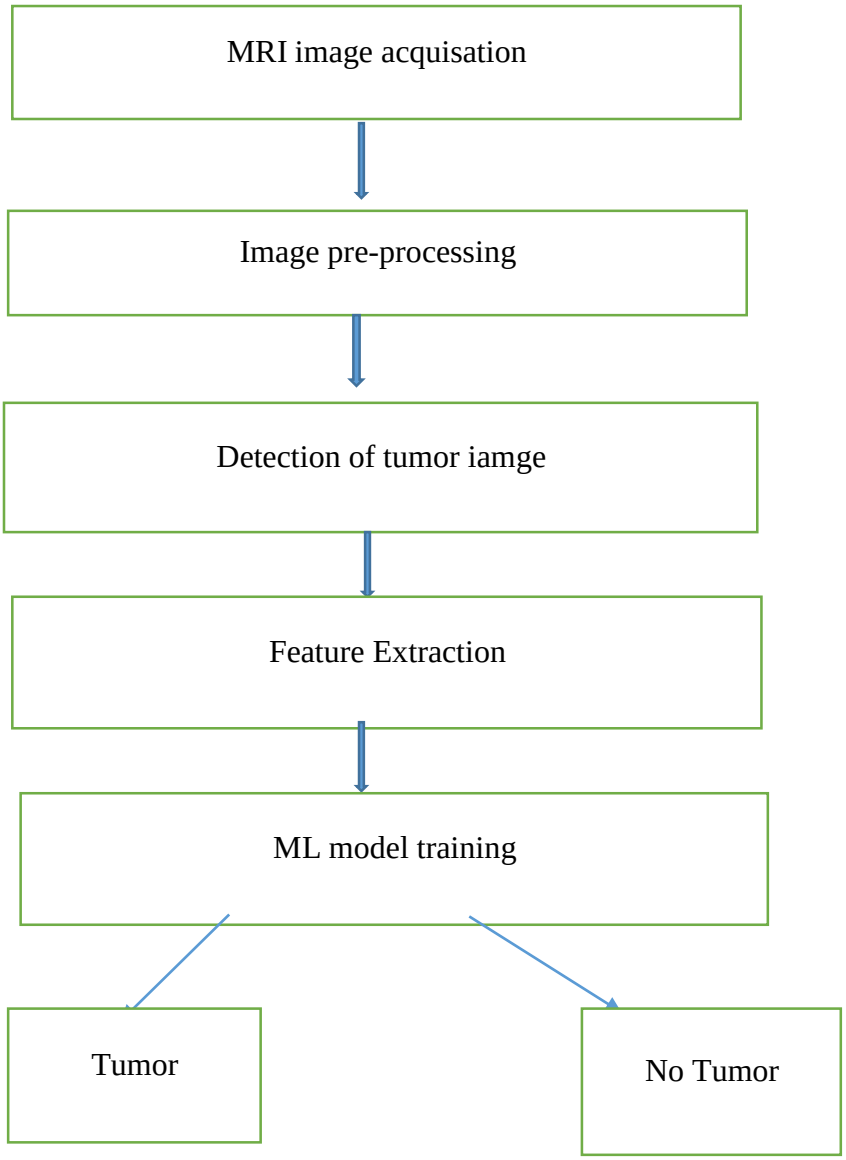


Fig. 2.2 Praposed system block diagram

Chapter 3

SYSTEM DEVELOPMENT

3.1 Proposed System

As per the survey has done the highest death rate in the world is due to a brain tumor. Symptoms include changes in the hormones, blood clot, weakness, uncontrolled walking, muddled speech, mood swings, loss in vision, etc. Location of tumor defines its type, and its proper diagnosis can save the life of the patient. Techniques like MRI or CT scan gives the complete structure of a brain tumor as it directs into the intracranial cavity producing a clear image of the tumor. MRI scan scans by using strong magnetic fields and high radio frequencies to provide detailed information of soft tissues. Compounded Tomography scan scans by sending X-ray beams. Basically, steps involved in detection of brain tumor are pre-processing of an image, feature extraction, segmentation, and post-processing of image.

3.1.1 Pre-Processing

Pre-processing of an image includes registration of image, correction filter for bias field and the removal of tissues which is not a part of the human brain. It also includes the removal of noise from the image, skull-striping, enhancement of the image, and many more.

3.1.2 Feature Extraction

It extracts the unique identities of an image like texture, shape, color and many more. Feature extraction is necessary to do segmentation of an image.

3.1.3 Segmentation

It is used to visualize and measure the brain's anatomical structure, and to extract the changes occurring in the brain, and to plan a surgery if needed. Mainly there are three segmentation methods for a human brain tumor and are semi-automatic segmentation, manual segmentation, and fully automatic segmentation. It improves the shape models of the image and helps in the classification of tissues.

3.1.4 Post-processing

This technique includes editing of images for obtaining a better result such as shape constraints of an image, spatial regularization as well as local constraints and many more. This provides a clear view of the tumor and the area of location Detection of the tumor is done in post processing.

3.2 Algorithms/Techniques used

3.2.1 GENETIC ALGORITHM

The genetic algorithm is a method for solving both constrained and unconstrained optimization problems that is based on natural selection, the process that drives biological evolution. The genetic algorithm repeatedly modifies a population of individual solutions. At each step, the genetic algorithm selects individuals at random from the current population to be parents and uses them to produce the children for the next generation. Over successive generations, the population "evolves" toward an optimal solution. You can apply the genetic algorithm to solve a variety of optimization problems that are not well suited for standard optimization algorithms, including problems in which the objective function is discontinuous, no differentiable, stochastic, or highly nonlinear. The genetic algorithm can address problems of mixed integer programming, where some components are restricted to be integer-valued.

The genetic algorithm uses three main types of rules at each step to create the next generation from the current population:

Selection rules select the individuals, called parents that contribute to the population at the next generation.

Crossover rules combine two parents to form children for the next generation.

Mutation rules apply random changes to individual parents to form children.

Present new region-based image segmentation methodology on gray-level images using a genetic algorithm with a fuzzy measure. We first propose a fuzzy validity function which measures a degree of separation and compactness between and within finely segmented regions, and an edge strength along boundaries of all regions. We apply the genetic algorithm to search a good or usable region segmentation, which maximizes the quality of regions generated by split- and-merge processing. The iterative algorithm provides a useful method for image segmentation without the need for critical parameters or threshold values, iterative visual interaction or *a* priori knowledge of an image.

ADVANTAGES, LIMITATIONS AND APPLICATIONS OF GENETIC ALGORITHM

3.2.2 Advantages of Genetic Algorithm

1. Parallelism.
2. Liability.
3. Solution space is wider.
4. The fitness landscape is complex.
5. Easy to discover global optimum.
6. The problem has multi objective function.
7. Only uses function evaluations.
8. Easily modified for different problems.
9. Handles noisy functions well.
10. Handles large, poorly understood search spaces easily.
11. Good for multi-modal problems, returns a group of solutions.
12. Very vigorous to difficulties in the evaluation of the objective function.
13. They are more resistant to becoming trapped in local optima.
14. They perform very well for large-scale optimization problems.
15. Can be employed for a wide variety of optimization problems.

3.2.3 Limitations of Genetic Algorithm

1. The problem of identifying fitness function.
2. Definition of representation for the problem.
3. Premature convergence occurs.
4. The problem of choosing the various parameters like the size of the population, mutation rate, cross over rate, the selection method and its strength.
5. Cannot use gradients.
6. Cannot easily incorporate problem specific information.
7. No effective termination point.
9. Not effective for smooth unimodal functions.
10. Needs to be coupled with a local search technique.
11. Have trouble finding the exact global optimum.

3.2.4 Applications of Genetic Algorithm

Genetic algorithms have been used for difficult problems (such as NP-hard problems), for machine learning and also for evolving simple programs. They have been also used for some art works, for evolving pictures and music. A few applications of GA are as follows:

- Strategy planning.
- Robot trajectory planning.
- TSP and sequence scheduling.
- Function Optimizations.
- Control–gas pipeline, missile evasion.
- Aircraft design and communication networks.
- Scheduling–manufacturing.
- Machine Learning–Designing neural networks, both architecture and weights, improving classification algorithms.

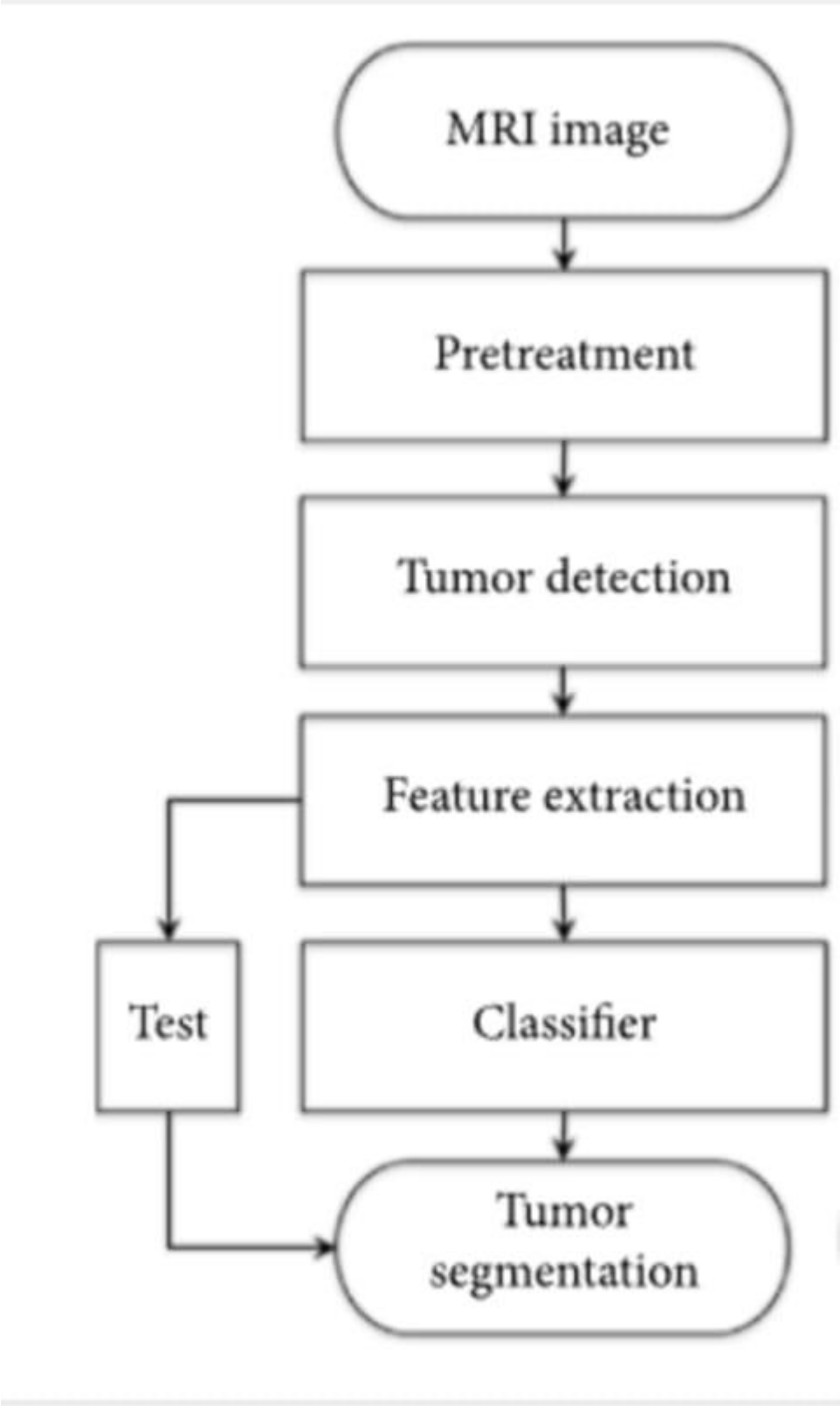


Fig. 3.1 Flowchart of Brain Tumor Segmentation

4. PERFORMANCE ANALYSIS

4.1 Tools/Techniques used:

4.1.1 Software Requirements:

1. Python:

Python is popular Programming language. Python is free and simple to learn. Its primary features are that it is **high-level**, **dynamically typed** and **interpreted**. This makes debugging of errors easy and encourages the rapid development of application prototypes, marking itself as *the language* to code with. Python was developed in 1989 by **Guido Van Rossum** and emphasizes on the *DRY* (Don't Repeat Yourself) principle and readability.

Python is used to develop Web application, Game development, Machine learning and Artificial Intelligence, Data Science and Data visualization, Desktop GUI, Web scraping application.

We use different Python Libraries in our project such as:

1. **NumPy**
2. **Matplotlib**
3. **Tkinter**
4. **CV2**

Image processing basically includes the following three steps:

Importing the image via image acquisition tools;

Analysing and manipulating the image;

Output in which result can be altered image or report that is based on image analysis.

4.1.2 Hardware Requirements:

1. PC
2. Visual Studio Code
3. Hard disk and Ram 8 GB

4.2 Implementation Details

4.2.1 Phase-1:

In phase 1, we perform Image Classification and Tumor Detection

First, we take the specific image from a dataset of brain tumor detection and then we upload it and then we plot the data. Then we perform scaling on the data and we displayed X, Y, Z dimensions of images, now we can analysis the dimensions of image to detect the type of brain tumor.

4.2.2 Choices of brain images

Currently, various imaging methods, such as X-Ray, CT scan, and Magnetic Resonance Imaging (MRI), are available through various techniques. The X-Ray provides picture evidence about the life structures and the whole synthesis of the brain or skull. Data containing the blood supply within the brain can be obtained with the aid of an MRI scan. As a consequence, it is fair to assume that MRI procedures have become an effective method for detecting oddity, monitoring the course of the disease, and making decisions.

4.2.3 Image pre-processing

The aim of the pre-processing stage is to optimise image data by suppressing unnecessary distortions and improving certain essential image features for subsequent processing. Image enhancement is a pre-processing method used to transform an initial image into a more desirable version. The following steps are followed in the pre-processing stage: The original image is paired with the sharpened images for further enhancement. When MRI scanned images are stored in a database, they are converted to grey scale image sizes of 255 x 255 since these photographs have been processed to eliminate noise, and the visual quality of the noise images has been affected. The high pass filter for edge detection and sharpening is responsible for the image's high resolution and lack of noise.

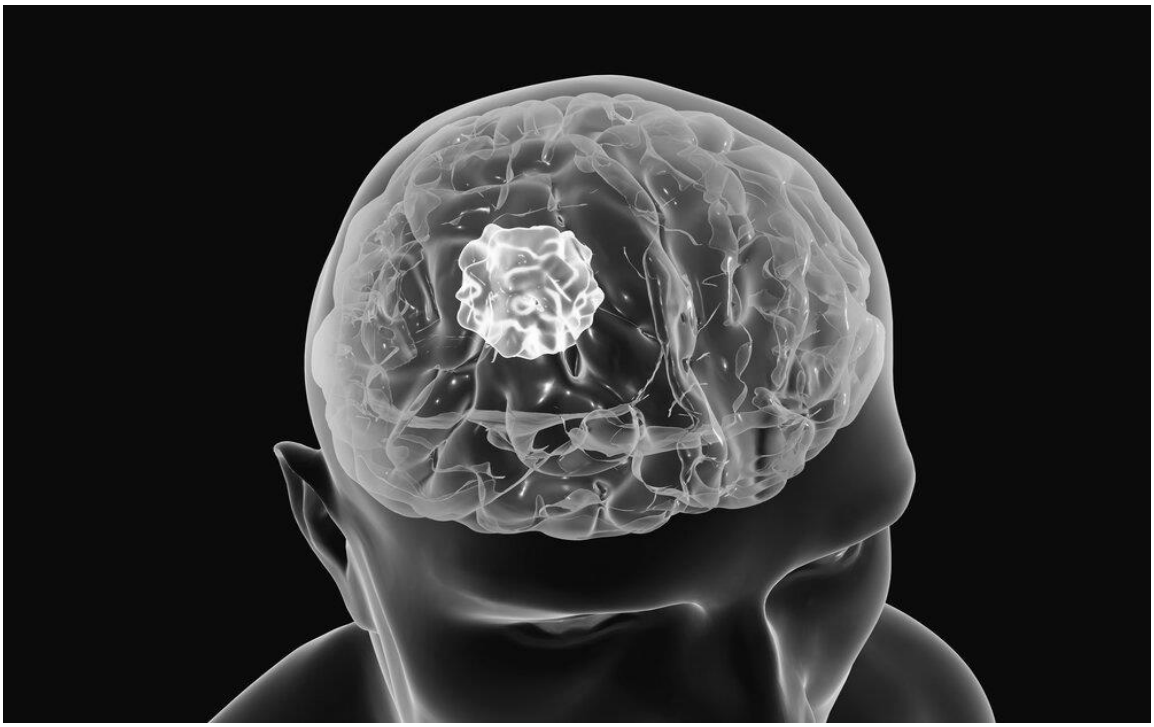


Fig. 3.2 Detection of brain tumor

4.2.4 Binarization

Because of the noise in the images, Auto encoders are not able to recognize the images. To avoid the background noise produced in the images we use Binarization technique. A colour image is made up of three channels (R, G, and B), each of which has a value ranging from 0 to 255. Converting greyscale images to black and white (0 to 1) is one of binarization's most important features. Binarization often makes the contours of different objects in the picture smoother and simpler. The learning of the model is improved by this function extraction.

4.2.5 Feature extraction:

This investigation focused on two viable GLCM surface features: homogeneity and vitality. The homogeneity quantifies the closeness of the dim level framework's circulation highlights. Furthermore, the Histogram of Oriented Gradients (HOG) descriptor is used to prepare the sectioned image, and PC type is used to remove the ideal element esteems.

4.2.6 GLCM

The Gray Level Co-Occurrence Matrix (GLCM) technique is a histogram of co-occurring grey scale values at a given offset over an image. The GLCM functions calculate how often the pixels pairs with unique values and in a given spatial relationship appear in an image create a GLCM, and then extract statistical measures from this matrix to describe the texture of an image. Texture classification using GLCMs.

4.2.7 HOG

Histogram of Oriented Gradients (HOG) is an element descriptor that is commonly used to distinguish highlights from image data. It is commonly used in computer vision projects for object detection. Finally, the HOG will generate a Histogram for each of these areas separately.

4.2.8 Detection of tumor

tect the region of brain tumor through machine learning we use DNN with stacked auto encoders for the Brain Tumor knowledge characterization, which enhances all evaluation measures of the diagnosis. As previously mentioned, the DNN classifier for the Brain Tumor dataset is designed using stacked auto encoders and the softmax layer. Two layers of auto encoders were layered on top of each other to create the DNN.

4.3 DATA ANALYSIS

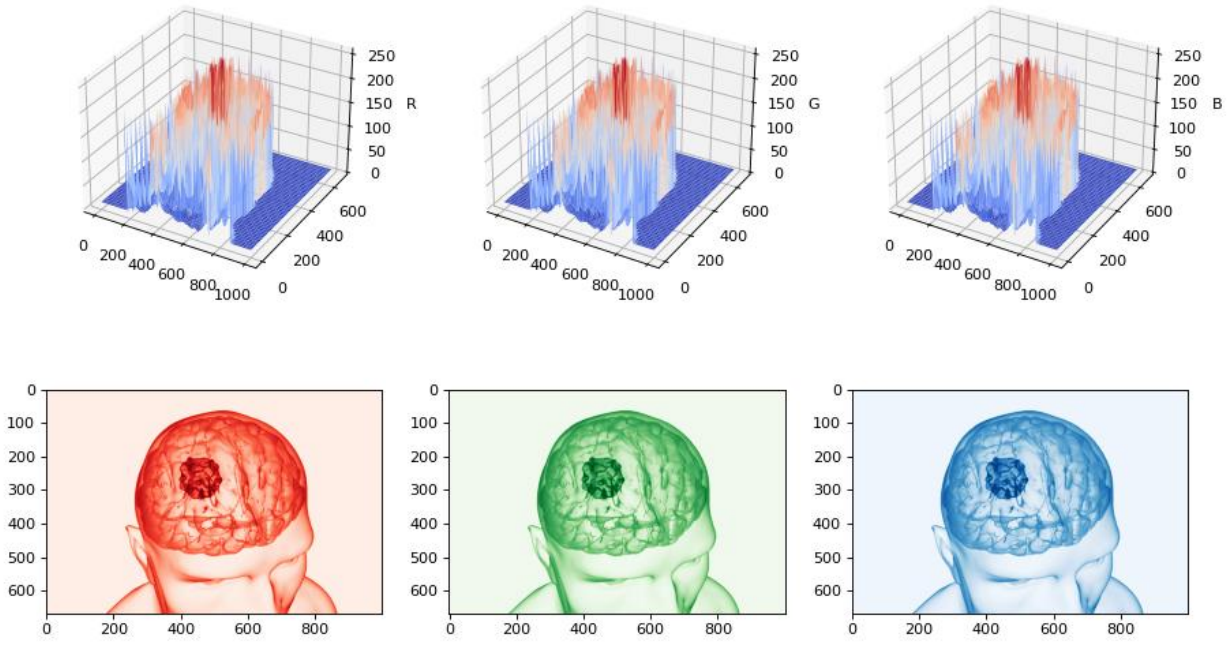
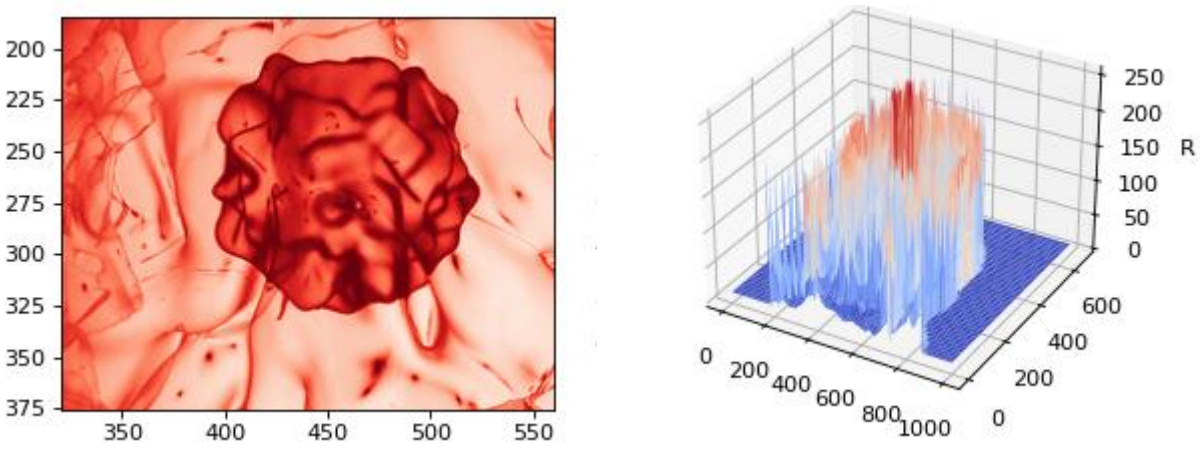


Figure 3.3 Scaling the data of images

4.3.1 DATA ANALYZING

1)

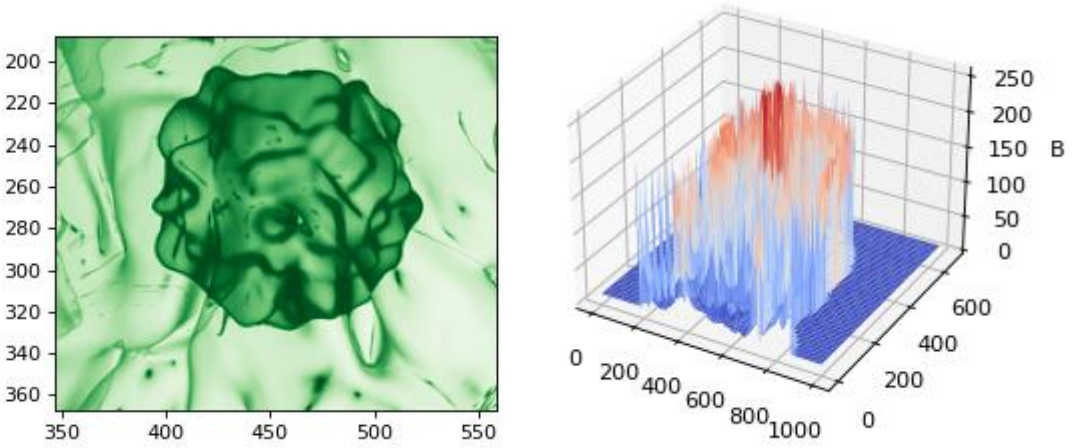


Dimensions:

X = 465.5, Y =278.2

Fig. 3.4 Segmented image of tumor

2)



Dimensions:

X =451, Y=283.2

Fig. 3.5 Segmented image of tumor

3)

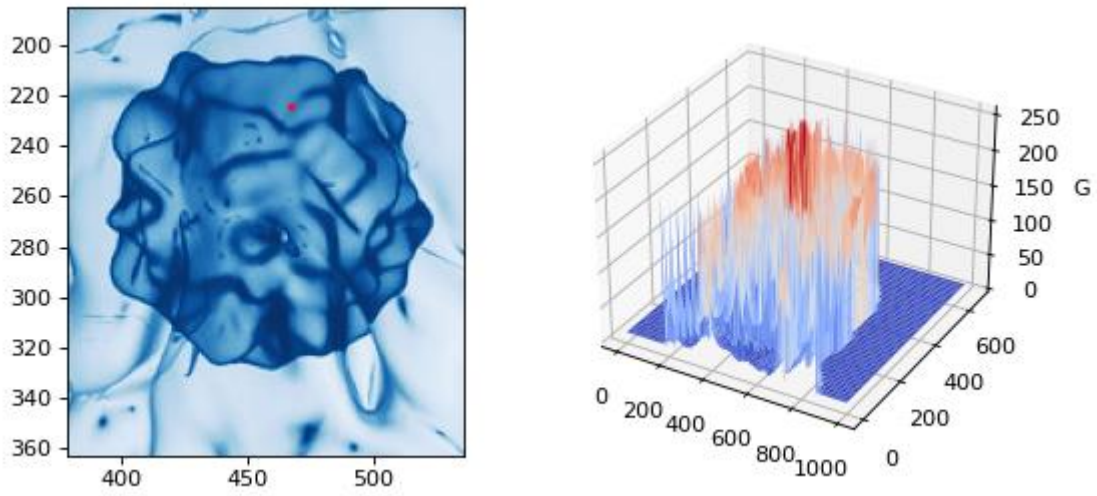


Figure 3.6 Fitting a Model

Dimensions:

X = 493.5, Y=277.35

Phase-2:

We define a function that displayed particles in Three-dimensional plot. And then we calculate:

- Mean Squared Error for the Test Set
- Predictions
- Dimensions

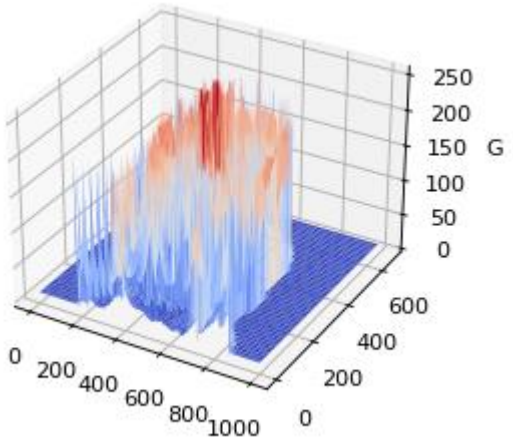


Figure 3.7 Function that displayed particles in Three-dimensional plot

Phase-3:

In phase-3 we perform the actual operation using the deep neural network and analysing the dimensions of brain tumor images for detecting and type of brain tumor.

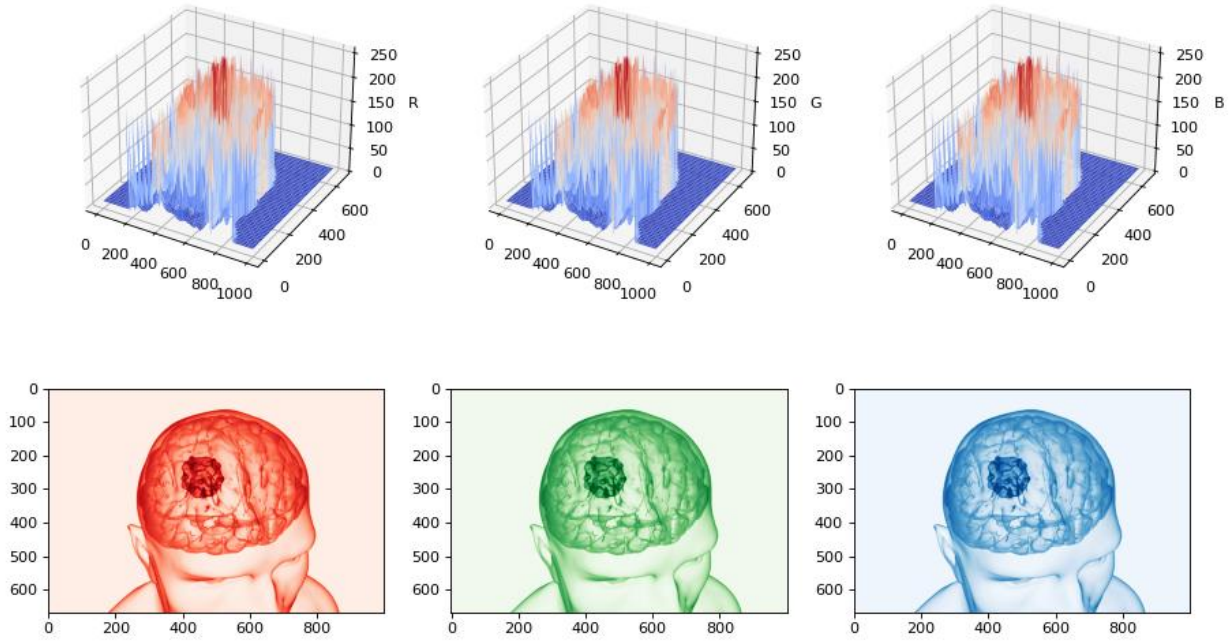


Fig. 3.8 Output of Brain tumor images

Chapter 4

PERFORMANCE ANALYSIS

4.3.4 Accuracy/ Testing

Classification of Accuracy is considered to be a final metric for examining the results delivered by a few techniques used in the dataset in the writing. The condition will provide classification accuracy. Where, N denotes the dataset to be sorted. Accuracy, Specificity, Precision, Recall, and F1-score are the four metrics used to evaluate a technique based on the parameters of the confusion matrix. There are four main terms:

True Positives: Situations where we predicted YES and the output was also YES.

True Negatives: Situations where expected NO and the output was also NO.

False Positives: Situations where we expected a YES but received a NO.

False Negatives: Circumstances where we expected NO but instead got YES.

These measurements are determined by the conditions mentioned below.

Chapter 5

CONCLUSION

5.1 Conclusions

In the field of medicine, brain image segmentation is critical in surgical preparation and treatment planning. We proposed a method for brain MR image segmentation for tumor location detection using the stacked auto encoders followed by DNN in this paper. Our model assists in anticipating a patient's Brian Tumor with greater exactness, particularity, precision, and analysis, all of which are important in the restorative world.

It has been proved from the study that brain tumour detection is used in many real life problem domains. When compared with other algorithms this is easy and needs only less parameter. This can be utilized to solve optimization problems as well as the problems that can be solved into optimization problems for fittest model. One of the noted application approaches is evolving Deep Neural Network. When hybridizing these two there is a remarkable performance. And thus, the future work of ours will be decision making in type of tumours detection Prediction using Deep Neural Network. This method will eventually cease the traditional Neural Network training algorithms because this is effective for any network architecture.

5.2 Future Scope

In the future, the proposed study could be expanded to include various types of modalities for detecting brain tumors, as well as the optimization method used to improve classification accuracy. In this research, we have used brain MR images, segmented into normal brain tissue (unaffected) and abnormal tumor tissue (infected). To remove a noise and smoothen the image, preprocessing is used which also results in the improvement of signal-to-noise ratio. Next, we have used discrete wavelet transform that decomposes the images and textural features were extracted from gray-level co-occurrence matrix (GLCM) followed by morphological operation. Probabilistic neural network (PNN) classifier is used for the classification of tumors from brain MRI images.

From the observation results, it can be clearly expressed that the detection of brain tumor is fast and accurate when compared to the manual detection carried out by clinical experts. The performance factors evaluated also shows that it gives better outcome by improving PSNR and MSE parameters.

The proposed methodology results in accurate and speedy detection of tumor in brain along with identification of precise location of the tumor.

In identification and classification into normal and abnormal tumors from brain MR images, accuracy of nearly 100% was achieved for trained dataset because the statistical textural features were extracted from LL and HL subbands wavelet decomposition and 95% was achieved for tested dataset. With the above results, we conclude that our proposed method clearly distinguishes the tumor into normal and abnormal which helps in taking clear diagnosis decisions by clinical experts.

In the future work, different classifiers can be used to increase the accuracy combining more efficient segmentation and feature extraction techniques with real- and clinical-based cases by using large dataset covering different scenarios.

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