**BASAVARAJESWARI GROUP OF INSTITUTIONS**

# BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

NBA and NACC Accredited Institution*

**(Recognized by Govt. of Karnataka, approved by AICTE, New Delhi & Affiliated to Visvesvaraya Technological University, Belgavi)**

**"JnanaGangotri" Campus, No.873/2, Ballari-Hospet Road,Allipur, Ballari-583 104 (Karnataka) (India)**

**Ph: 08392 – 237100 / 237190, Fax: 08392 – 237197**

## DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

## A Project Report On

# "Brain Tumor Detection using MRI Image Processing"

**A dissertation submitted to the Department of Computer Science and Engineering of Visvesvaraya Technological University in partial fulfillment for the award of the Degreeof Bachelor of Engineering.**

***Submitted By***

**CHANDRASHEKAR G** **3BR18CS035**

**Under the Guidance of**

**Dr. ARADHANA D**

**PROFESSOR & HEAD OF THE DEPARTMENT**

**BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT, BALLARI**

# Visvesvaraya Technological University

**Belagavi, Karnataka**

**2021-2022**

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## DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

# CERTIFICATE

This is to certify that the PROJECT WORK entitled "**Brain Tumor Detection using MRI Image Processing"** has been successfully presented by **Chandrashekar** bearing USN **3BR18CS035** student of VIII semester B.E. for the partial fulfillment of the requirements for the award of **Bachelor'sDegree in Computer Science & Engineering** of the VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI during the academic year 2021-2022.

| Signature of guide | Signature of HOD | Signature of Principal |
|---|---|---|
| **Dr. Aradhana D** | **Dr. R. N. Kulkarni** | **Dr. Yadavalli Basavaraj** |

EXTERNAL VIVA

| Name of the Examiners | Signature and date |
|---|---|
| 1. ……. | …… |
| 2. ……. | …… |

# ABSTRACT

Brain Tumor detection and identification based on analysis using MRI images is essential to assist medical doctors during the diagnosis and treatment process. This project proposes a new feature extraction using GLCM (Gray-Level Co-occurrence Matrix). This proposed method uses image processing to perform feature extraction on MRI images. This proposed method is compared against the traditional techniques. Based on the final performance of the project, we can evaluate whether the proposed application is a valid alternative to be used in real-time applications or not.

# ACKNOWLEDGEMENT

We express our warm and profound sense of gratitude to all the eminent faculties who inspired, guided and supported us in accomplishing our project work.

We deeply indebted to **Dr. Aradhana D**, Department of CSE , our guide on this project & coordinator **Prof. C. K. Srinivas** on this project, for consistently providing us with the required guidance to help us in the timely and successful completion of this project. In spite of his extremely busy schedules in Department, he was always available to share with us his deep insights, wide knowledge and extensive experience.

We are much obliged to our honourable Head of the Department **Dr. R. N Kulkarni** for understanding the capability in us to complete the project successfully and also we are thankful to him for encouraging us and being motivation and inspiration for us.

We extend our warm thanks to our Principal **Dr. Yadavalli Basavaraj** for giving us the moral support and providing us all kinds of facilities.

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Last but not the least we also thank our beloved friends who were there with us all the time supporting, providing assistance and giving us enough strength to successfully complete our project and also proving the popular saying, “A Friend in need is a Friend indeed” to be true.

| NAME | USN |
| --- | --- |
| Chandrashekar G | 3BR18CS035 |

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# CHAPTER 1

# INTRODUCTION

## 1.1 OVERVIEW:

The development of aberrant cells within the brain leads to the development of a brain tumor. Tumors can be classified into two categories: malignant (cancerous) tumors and benign (non-cancerous) tumors. Cancerous tumors can be separated into primary tumors, which begin inside the brain, and secondary tumors, or brain metastasis tumors, which have spread from somewhere else. Depending on where a section of the brain is affected, all types of brain tumors can cause a variety of symptoms. Headaches, seizures, eye issues, nausea, and mental disturbances are a few examples of these symptoms. MRIs are appropriate for tumor detection when all other tests are insufficiently informative. To provide precise images, an MRI scan takes advantage of the magnetic and radio wave properties. MRIs are most frequently prescribed by neurosurgeons because they give them enough information to spot even the smallest abnormalities.

## 1.2 EXISTING SYSTEM:

Medical image segmentation for detection of brain tumor from the magnetic resonance (MR) images is a very important process for deciding right therapy at the right time. Many techniques have been proposed for classification of brain tumors in MR images, most notably, fuzzy clustering means (FCM), support vector machine (SVM), artificial neural network (ANN), knowledge-based techniques, and expectation maximization (EM) algorithm technique which are some of the popular techniques used for region-based segmentation and so to extract the important information from the medical imaging modalities. The existing systems can only detect the tumors but cannot classify them.

## 1.3 PROPOSED SYSTEM:

The proposed system will overcome the limitations of existing system by using anatomical structure of the brain slices for the classification. The MRI images are processed for getting a gray-coloured image and then using image segmentation, image classification techniques to detect tumor. In this system, CAD (Computer Aided Diagnosis) framework is produced utilizing FDA features and machine learning based back propagation Neural Network to detect the brain Tumor of the size below 3mm which could not be detected using CT. The images are acquired and stored in the local storage. The images are then accessed using Open-CV software. Highlight extraction is finished by utilizing dark level covariance network and then the MLBPNN classifier is used to classify the tumor type. The system reads and process the selected image and displays the output image on monitor.

## 1.4 PROBLEM STATE1MENT AND SCOPE OF THE PROJECT:

**Problem statement:**

To design and develop an efficient and automatic system to detect tumors in MRI images using image processing.

**Scope of the project:**

- In order to detect tumor in MRI the project needs images with minimum of 180 X 180 pixels and maximum of 1920 X 1080 pixels.
- Minimum of 40 images for training dataset.

## 1.5 VISION AND MISSION, OBJECTIVES:

**Vision:**
To detect and classify the brain tumor present in MRI image using image processing technology

**Mission:**
To perform feature extraction using GLCM (Gray-Level Co-occurrence Matrix) and classification using MLBPNN (machine learning based Back Propagating Neural Network) on image of MRI scan of the Brain.

**Objectives:**

- To acquire dataset of MRI scan images to train our machine learning model.
- To use Feature Extraction and classification on MRI scan image.
- To design and develop a machine learning model to identify Brain tumor.
- To have a dependable system that can quickly detect tumors at the click of a button.

# CHAPTER 2

# LITERATURE SURVEY

In Paper **[1]**, the authors proposed method that is essential for brain image segmentation from MRI image. The evaluated results from parameters are Error Rate (MSE) value with 1.509, and Exact value (Accuracy Rate) value with 98.58 %.

In Paper **[2]**, the authors have used Gaussian filter for filter the brain MRI image and GLCM is used for feature extraction method followed by Convolutional Neural network for classification of processed image. Here author is only just classifying the brain MRI image contain Tumor or not.

In Paper **[3]**, The propositioned method by authors entails of four stages explicitly preprocessing, dissection, feature extraction, feature reduction and classification. In preprocessing wiener filter is harnessed for noise reduction and to render the image apposite for extracting the features. In the second stage, amended region convalescing base dissection is used for apportioning the image into momentous regions. In the third stage, combined edge and Texture based features are extricated using Histogram and Co-occurrence Matrix then Principal Component Analysis (PCA) is depleted to demote the dimensionality of the feature space which results in a more efficient and accurate classification.

In Paper **[4]**, the author has proposed a technique of automatic feature extraction for brain tumor detection based on Gaussian mixture model (GMM) using MR images. In this method, using principal component analysis (PCA) and wavelet-based features, the performance of the GMM feature extraction is enhanced. An accuracy of 97.05% for the T1-weighted and T2-weighted and 94.11% for FLAIR weighted MR images are obtained.

In Paper **[5]**, Authors propose a learning-based system for programmed and hearty and core division with shape protection. In this work at first create a likelihood delineate utilizing Convolution Neural Network (CNN) for given core picture.

In Paper **[6]**, The authors used the technique that hits the target with the aid of the following major steps, which includes: Pre-processing of the brain images., segmentation of pathological tissues (Tumor), normal tissues (White Matter (WM) and Gray Matter (GM)) and fluid (Cerebrospinal Fluid (CSF)), extraction of the relevant features from each segmented tissues and classification of the tumor images with NN. As well, the experimental results and analysis is evaluated by means of Quality Rate (QR) with normal and the abnormal Magnetic Resonance Imaging (MRI) images.

In Paper **[7]**, The authors implemented a system that determines the type of the tumor which is benign or malignant using the Magnetic Resonance Imaging (MRI) images which are in the Digital Imaging and Communications in Medicine (DICOM) standard format. The system is assessed based on a series of brain tumor images. Experimental results demonstrate that the proposed system has a classification accuracy of 98.9%.

# CHAPTER 3
# REQUIREMENTS

## 3.1 FUNCTIONAL REQUIREMENTS:

- The system must be able to analyze the loaded dataset.
- It should be able to extract texture features of the tumor.
- The system must be able to accurately predict the presence or absence of tumor for the given data.
- It should display the tumor type.

## 3.2 NON-FUNCTIONAL REQUIREMENTS:

- **Data Integrity**: This project maintains the assurance of data accuracy and consistency over its entire life cycle.
- **Usability**: It is easy for the user to understand and use the application with simple training.
- **Maintainability**: The system is capable of application through changes with a fair degree of effortlessness.
- **Scalability**: The system should be developed in such a way that new modules and functionalities can be added, thereby facilitating system evolution.

## 3.3 HARDWARE AND SOFTWARE REQUIREMENTS:

**Hardware Requirements:**

- Hard Disk : 500 GB
- RAM : 8 GB
- Processor : Intel i3 2.4 GHz
- Mouse : Standard Optical Mouse
- Keyboard : Standard Windows Keyboard

**Software Requirements:**

- Operating System : Windows 10
- Software Tool : Open CV
- Coding Language : Python
- Toolbox : Image processing toolbox
- IDE : Python IDLE

# CHAPTER 4

# SYSTEM DESIGN

## 4.1 SYSTEM ARCHITECTURE:

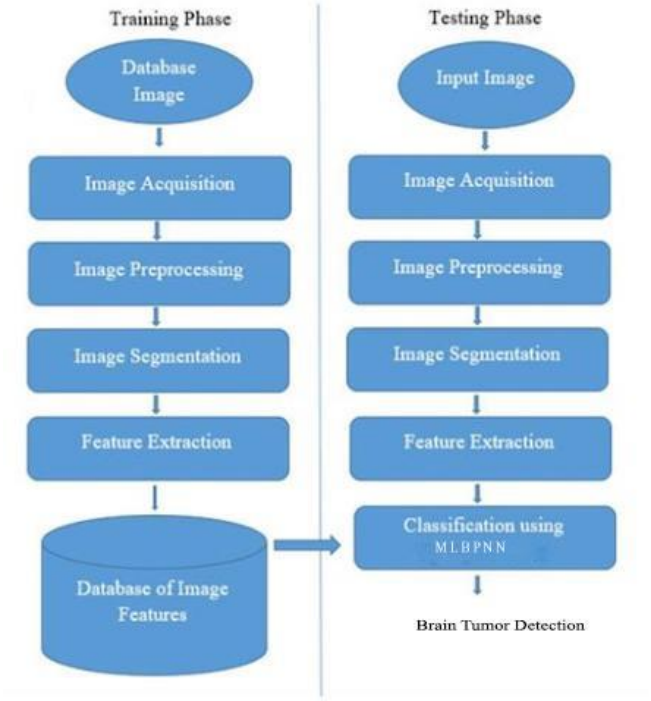


Figure 4.1.1 System Architecture

**Image acquisition:** The adulteration fruit image is acquired using the camera and the image is acquired from a certain uniform distance with sufficient lighting for learning and classification.

**Image pre-processing:** The noise reduction using averaging filter, color transformation, and histogram equalization are used in the pre-processing of digital camera-acquired images.

**Segmentation:** There are numerous methods for segmenting images, including neural network-based, edge-based, cluster-based, and threshold-based methods.

**Feature Extraction**: The features must be extracted from the input photos. In order to achieve this, we can select only those pixels that are required and adequate to fully represent the segment.

**Classification using MLBPNN:** The Backpropagation neural network is a multi-layered, feedforward neural network and is considered one of the simplest and most general methods used for supervised training of multi-layered neural networks.

## 4.2 USE CASE DIAGRAM:

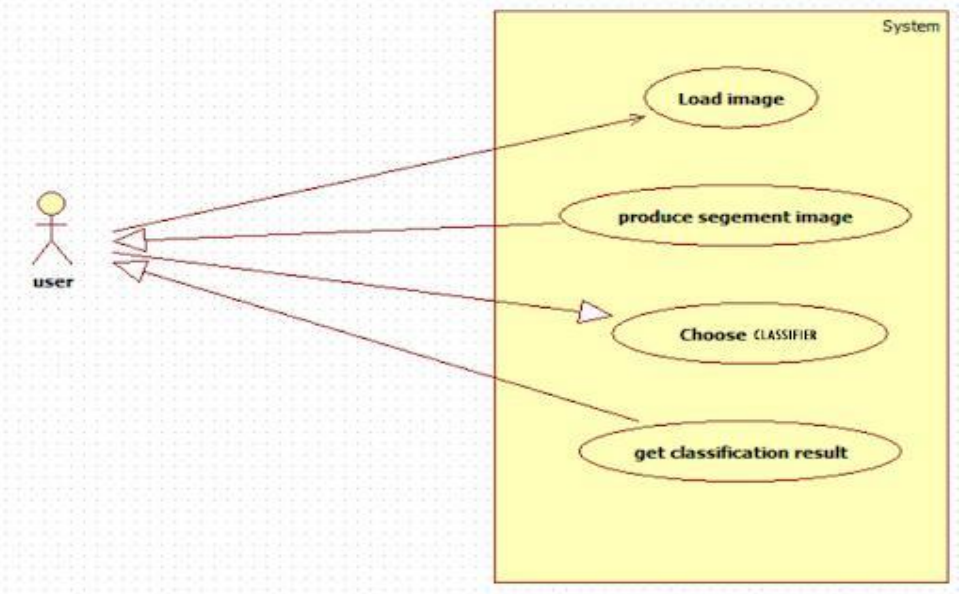


Figure 4.2.1 Use Case Diagram

A use case diagram is a graph of actors, a set of use cases enclosed by a system boundary, communication associations between the actors and users and generalization among use cases.

A use case diagram is a visual representation of how a user might interact with a program. A use case diagram depicts the system's numerous use cases and different sorts of users. System collects the dataset for performing detection of brain tumor. Then the data is pre-processed and trained.

## 4.3 SEQUENCE DIAGRAM:

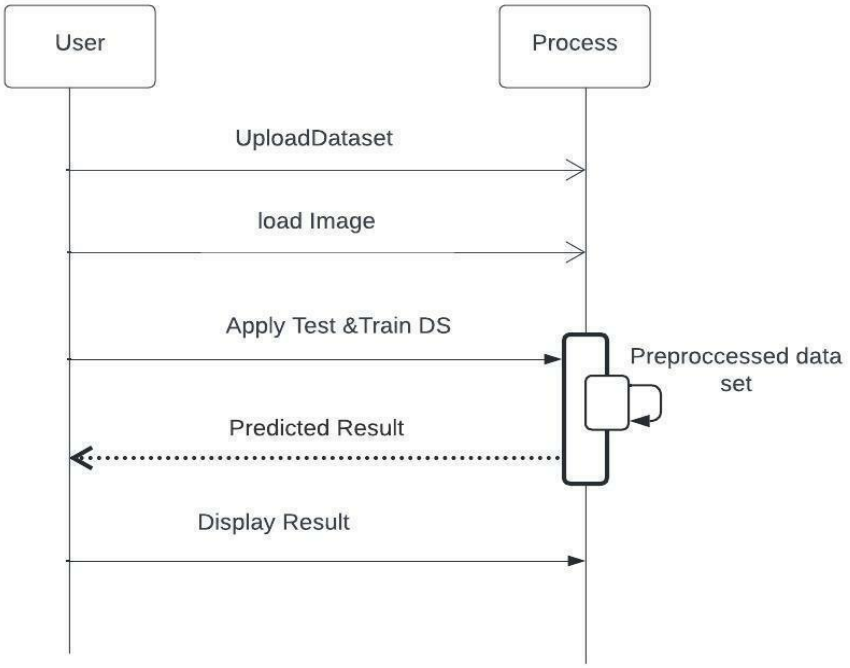


Fig 4.2.1 Sequence diagram

A Sequence diagram is a kind of interactions that shows how processes operate with one another and in what order. A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario.

## 4.4 SEQUENCE DIAGRAM:

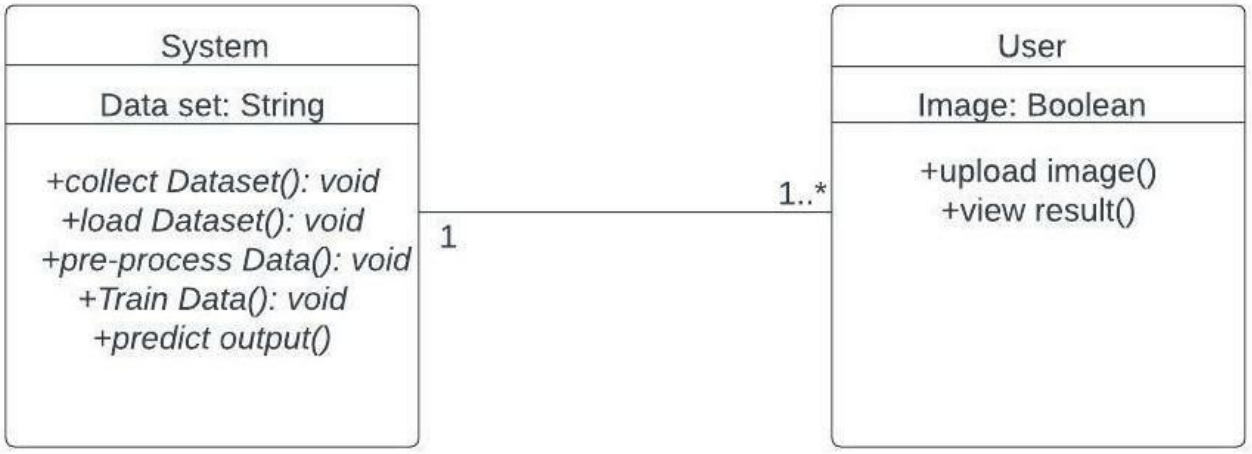


Fig 4.4 Class Diagram

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains (what kind of) information. In the given class diagram, we can clearly see the two classes mentioned, which communicate with one another- system and user, whose respective operations are given.

# CHAPTER 5
# IMPLEMENTATION

## 5.1 MODULES

### 5.1.1 Python IDE

Python is an easy to learn, powerful programming language. It has efficient high-level data structures and a simple but effective approach to object-oriented programming. Python's elegant syntax and dynamic typing, together with its interpreted nature, make it an ideal language for scripting and rapid application developmentin many areas on most platforms

### 5.1.2 OpenCV

OpenCV is a library of programming functions mainly aimed at real-time computer vision. It has a modular structure, which means that the package includes several shared or static libraries. We are using image processing module that includes linear and non-linear image filtering, geometrical image transformations (resize, affine and perspective warping, and generic table-based remapping), colour space conversion, histograms, and so on. Our project includes libraries such as Viola-Jones or Haar classifier, LBPH (Lower Binary Pattern histogram) face recognizer, Histogram of oriented gradients (HOG).

### 5.1.3 OpenCV-Python working

OpenCV introduces a new set of tutorials which will guide you through various functions available in OpenCV-Python. This guide is mainly focused on OpenCV 3.x version (although most of the tutorials will work with OpenCV 2.x also).

A prior knowledge on Python and Numpy is required before starting because they won't be covered in this guide. Especially, a good knowledge on Numpy is must to write optimized codes in OpenCV-Python.

This tutorial has been started by *Abid Rahman K.* as part of Google Summer of Code 2013 program, under the guidance of *Alexander Mordvintsev*.

**Getting Started with ImagesGoals**

To read an image, to display it and to save it back

We will use these functions : **cv2.imread()**, **cv2.imshow()** , **cv2.imwrite()**

Optionally, we will use display images

with MatplotlibUsing OpenCV

**Read an image**

Use the function **cv2.imread()** to read an image. The image should be in the working directory or a full path of image should be given.

Second argument is a flag which specifies the way image should be read.

cv2.IMREAD_COLOR : Loads a colour image. Any transparency of image will be neglected. It is the default flag.

cv2.IMREAD_GRAYSCALE : Loads image in greyscale
mode cv2.IMREAD_UNCHANGED : Loads image as such
including alpha channel

**Display an image**

Use the function **cv2.imshow()** to display an image in a window. The window automatically fits to the image size.

First argument is a window name which is a string. second argument is our image. You can create as many windows as you wish, but with different window n**cv2.waitKey()** is a keyboard binding function. Its argument is the time in milliseconds. The function waits for specified milliseconds for any keyboard event. If you press any key in that time, the program continues. If **0** is passed, it waits indefinitely for a key stroke. It can also be set to detect specific key strokes like, if key *a* is pressed etc which we will discuss below.

**cv2.destroyAllWindows()** simply destroys all the windows we created. If you want to destroy any specific window, use the function **cv2.destroyWindow()** where you pass the exact window name as the argument.

# CHAPTER 6

## SYSTEM TESTING

System testing is a critical aspect of Software Quality Assurance and represents the ultimate review of specification, design and coding. Testing is a process of executing a program with the intent of finding an error. A good test is one that has a probability of finding an as yet undiscovered error. The purpose of testing is to identify and correct bugs in the developed system. Nothing is complete without testing. Testing is vital to the success of the system.

In the code testing the logic of the developed system is tested. For this every module of the program is executed to find an error. To perform specification test, the examination of the specifications stating what the program should do and how it should perform under various conditions.

Unit testing focuses first on the modules in the proposed system to locate errors. This enables to detect error in the coding and logic that are contained within the module alone. Those resulting from the interaction between the modules are initially avoided. In unit testing step each has to be tested separately.

Testing and validation are the most important steps after the implementation of the developed system. The system testing is performed to ensure that there are no errorsin the implementation system. The software must be executed several times in order tofind out the errors in the different modules of the system.

Validation refers to the process of using the new software for the developed system in a live environment i.e., new software inside the organization, in order to find out the errors. The validation phase reveals the failures and the bugs in the developed system. It will come to know about the practical difficulties the system faces when operated in the true environment.

Testing may be done at different levels

- Unit level
- Module level
- Integration and system level

## 6.1 UNIT TESTING:

| Case No | Description | Expected Output | Actual Output | Remarks |
|---|---|---|---|---|
| 1. | Upload Dataset | Choose a dataset file from the user's systemdirectories. Upload the dataset. | Dataset file is loaded onto the system. | SUCCESS |
| 2. | Pre-processing Dataset | Dataset is pre-processedfor further usage. | Display pre-processed dataset. | SUCCESS |
| 3. | Upload Image | User uploads image asinput. | Image Uploaded. | SUCCESS |
| 4. | Predict Output | Image is uploaded thenthe output is predicted. | Output is predicted. | SUCCESS |
| 5. | Predict results | Prediction of results after comparative analysis of the dataset. | Display accuracy level of the machine learning algorithm. | SUCCESS |

Table 6.1.1 Unit Testing

Table 6.1.1 Unit Testing Table

## 6.2 MODULE LEVEL TESTING

Module testing is done at each module using test cases as prepared above. Module level testing examines the output of every module involved. Modules are designed during the time of design.

## 6.3 INTEGRATION AND SYSTEM TESTING

Integration testing is used to verify the combining of the software modules. Integration testing addresses the issues associated with the dual problems of verification and program construction. System testing is used to verify, whether the developed system meets the requirements.

# CHAPTER 7

# SNAPSHOTS

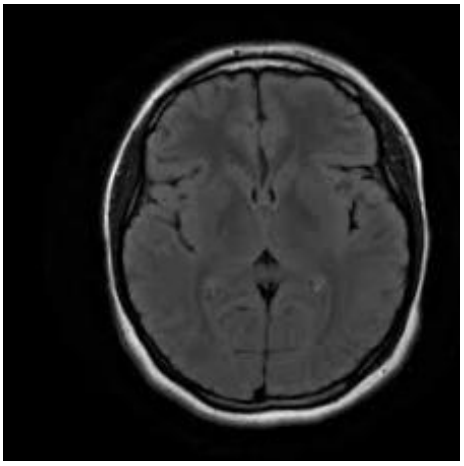

Fig 7.1 MRI image with no tumor

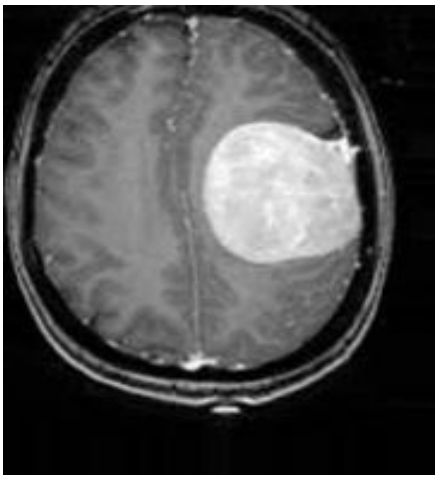

Fig 7.2 MRI image with tumor

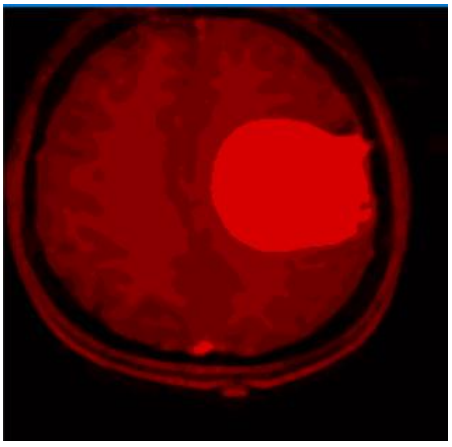

Fig 7.3 Image after noise removal and image enhancement

Fig 7.4 Segmented Image

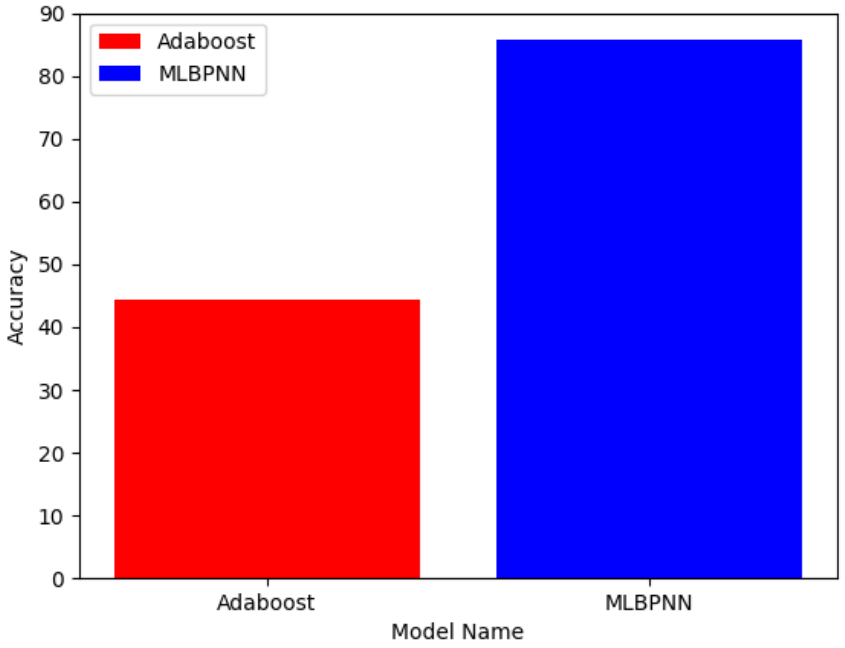


Fig 7.5 Graph comparing the accuracy of Adaboost and MLBPNN

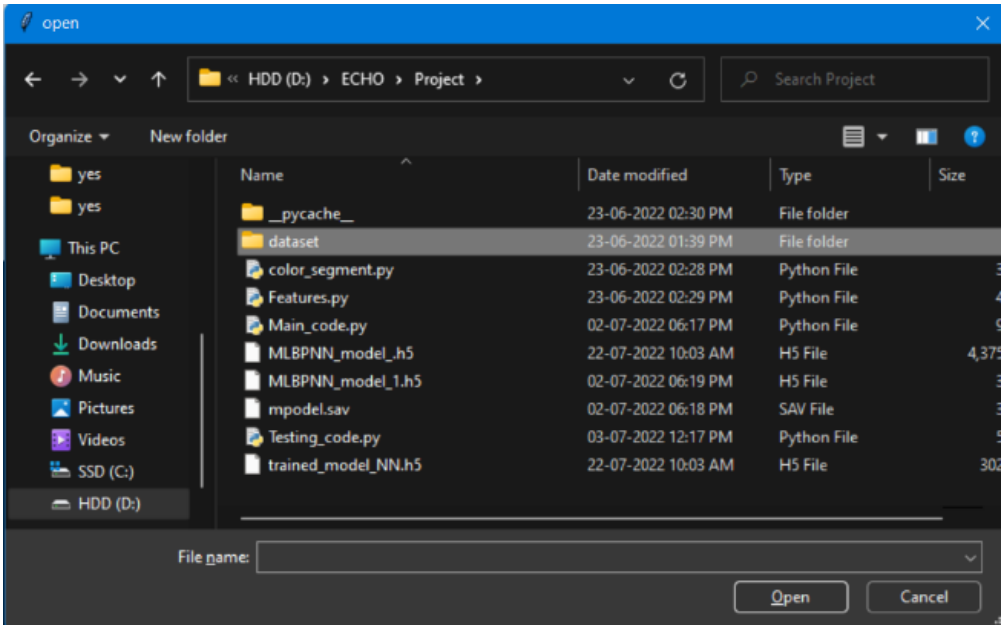


Fig 7.6 Window to select MRI image

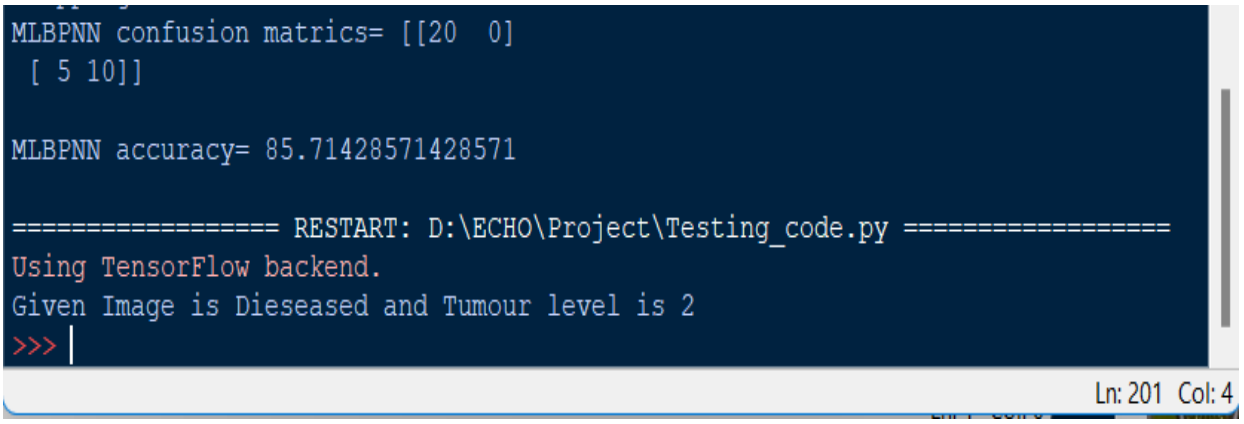


Fig 7.7 Output for image with tumor

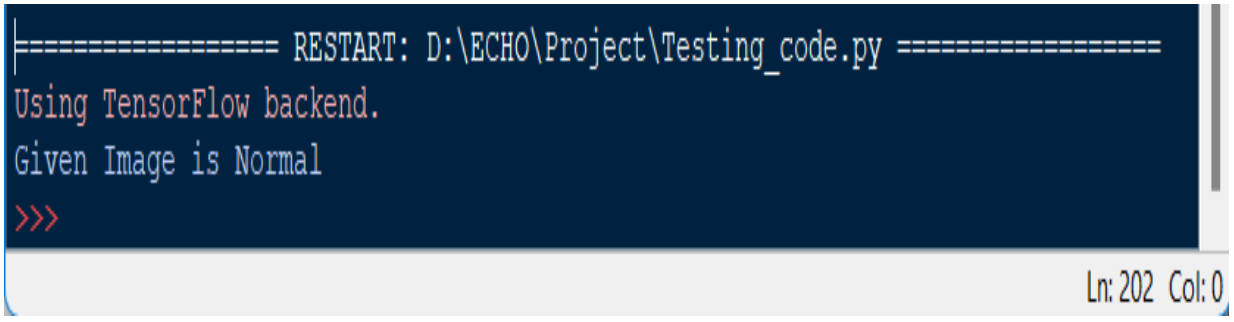


Fig 7.8 Output for image with no tumor

# CHAPTER 8

# CONCLUSION

## 8.1 CONCLUSION

When recognizing and segmenting the tumor image, the MLBPNN (machine learning-based Back Propagating Neural Network) system has significant practical utility. Based on their size, the tumor images are further divided into classes I and II. On a number of parameters, a comparison between the Adaboost Classifier and the MLBPNN has been done. It is clear from the results that MLBPNN is more effective than the Adaboost Classifier.

## 8.2 FUTURE SCOPE:

In this project, we demonstrated only tumor detection which were present in MRI scans and it can be extended for more types of deceases in future. By that the doctors can accurately prescribe required treatments to affected patients. This system can further be developed by including the vision-based detection system.

# REFERENCES

[1] Sonali Bansal, Shubpreet Kaur, Navdeep Kaur," Enhancement in Brain Image Segmentation using Swarm Ant Lion Algorithm", ISSN: 2278-3075, Volume-8 Issue 10, August 2019.

[2] Harshini Badisa, Madhavi Polireddy, Aslam Mohammed, "CNN Based Brain Tumor Detection", ISSN: 2249 – 8958, Volume-8 Issue-4, April 2019.

[3] P. Kumar and B. Vijayakumar, "Brain tumor MRI image segmentation and classification using by PCA and RBF kernel-based support vector machine," Middle East Journal of Scientific Research, vol. 23, no. 9, pp. 2106–2116, 2015.

[4] A. Chaddad, "Automated feature extraction in brain tumor by magnetic resonance imaging using gaussian mixture models," International Journal of Biomedical Imaging, vol. 2015, Article ID 868031, 11 pages, 2015

[5] Fuyong Xing, YuanpuXie, Lin Yang, "An Automatic Learning-Based Framework for Robust Nucleus Segmentation",IEEE Transactions on Medical Imaging, Vol.35, Issue.2, PP.550 – 566, 2016.

[6] S. Damodharan and D. Raghavan, "Combining tissue segmentation and neural network for brain tumor detection," International Arab Journal of Information Technology, vol. 12, no. 1, pp. 42–52, 2015.

[7] M. Alfonse and A.-B. M. Salem, "An automatic classification of brain tumors through MRI using support vector machine," Egyptian Computer Science Journal, vol. 40, pp. 11–21, 2016.

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**BALLARI INSITUTE OF TECHNOLOGY AND MANGEMENT, BALLARI**
**DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING**
**Project CO-PO Mapping**
**ACADEMIC YEAR 2021-22**

| U.S.N. | Student Name | Guide Name | Project Title |
|---|---|---|---|
| 3BR18CS055 | GURUSAI | DR. ARADHANA D | Brain Tumor Detection Using MRI Image Processing |
| 3BR18CS035 | CHANDRASHEKAR G | | |
| 3BR18CS058 | HARISH JJ | | |
| 3BR18CS052 | GS NAYEEM | | |

## COURSE OUTCOMES(CO'S)

| Course Outcomes COx | Description of Course Outcomes |
|---|---|
| **CO1** | **Identify** the problem in the field of medical science. |
| **CO2** | **Analyze** the problem of tumor in human brain. |
| **CO3** | **Design** the solution methodologies for the detection of brain tumor of patients |
| **CO4** | **Write** technical Project report by following professional ethics |
| **CO5** | **Create** and publish the outcome of the thesis into an article |

## CO-PO MAPPING

| CO-PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | | | 1 | | | | | | | | | |
| **CO2** | | 3 | | 1 | | | | | | | | | | |
| **CO3** | | 1 | 3 | | 1 | | | | | | | | | |
| **CO4** | | | | | | | | | | 3 | | 1 | 1 | |
| **CO5** | | | | | | | | 1 | 1 | 2 | | 1 | | 1 |

**Signature of Guide**

## PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

**PO**1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
**PO**2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and

engineering sciences.

**PO**3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO**4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO**5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO**6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO**7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO**8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO**9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO**10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO**11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**PSO1.** Understand the principles, architecture and organization of computers, embedded systems and computer networks

**PSO2.** To develop software applications using advanced technologies to cater the growing needs of industry.

## Project Guide -

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