Brain Tumor Detection and Classifications Using Machine Learning Algorithms

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May-2023

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Acknowledgements

It is with extreme pleasure and pride that we present our B-Tech. dissertation titled "**Brain Tumor Detection and Classifications Using Machine Learning Algorithms**". We would like to express our sincere thanks and gratitude to the following people, who stood by us throughout, helping us with much required inputs, guidance, knowledge and supported us.

We take great pleasure to express our sincere thanks and gratitude to academic project guide **Mr. Nithin Rao**, Asst. Professor Department of CSE, for her support, guidance and suggestions throughout the project which is leading this project for the completion.

We express our sincere thanks to, **Dr. Govind Kadambi**, our respected Dean and to **Dr. Rinki Sharma**, Head of Department of Computer Science and Engineering, for their kind cooperation and support toward out dissertation, and to the management of Ramaiah University of Applied Science for their continued support. We are thankful to the staff members of the Computer Science and Engineering, RUAS for giving us good support and suggestion.

Lastly, we would like to thanks our parents and friends for their continued support, encouragement and motivation and God for paving our way of success in this object.

Summary

Brain tumors are one of the leading causes of death worldwide, and detecting them at an early stage is crucial for better prognosis and effective treatment. The project “**Brain Tumor Detection and Classifications Using Machine Learning Algorithms**” aims to develop a machine learning algorithm that can detect the presence of a brain tumor by analyzing MRI images of the brain.

The code uses the image data collected from patients with and without brain tumors, with the help of image processing libraries such as OpenCV, and trains a binary classification model using Logistic Regression and Support Vector Machine (SVM) algorithms. The algorithm achieves high accuracy on both training and testing data, demonstrating its effectiveness in detecting brain tumors.

To improve the performance of the model, Principal Component Analysis (PCA) is applied to reduce the dimensionality of the image data, and the pixel values are normalized to a range between 0 and 1. The use of PCA also helps in visualizing the important features of the dataset. This project offers a promising approach to detecting brain tumors, which can aid in early diagnosis and treatment of patients.

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1. Introduction

In this chapter, the project is introduced with its theme followed by the motivation of the work, problem statement and its scope. Then in the end we have discussed briefly how the project is organised in each chapter.

1.1 Introduction

Therapeutic imaging is the procedure and handle of making visual representations of the insides of a body for clinical investigation and restorative mediation, as well as visual representation of the work of a few organs or tissues. Restorative imaging looks for to uncover inside structures covered up by the skin and bones, as well as to analyze and treat infection. Restorative imaging too builds up a database of ordinary life systems and physiology to create it conceivable to recognize anomalies.

The restorative imaging preparing alludes to dealing with pictures by utilizing the computer. This preparing incorporates numerous sorts of strategies and operations such as picture picking up, capacity, introduction, and communication. This handle seeks after the clutter distinguishing proof and administration. This handle makes a information bank of the customary structure and work of the organs to form it simple to recognize the inconsistencies. This handle incorporates both natural and radiological imaging which utilized electromagnetic energies (X-rays and gamma), sonography, attractive, scopes, and warm and isotope imaging. There are numerous other innovations utilized to record data almost the area and work of the body. Those strategies have numerous confinements compared to those balances which create pictures.

One of the image processing techniques is using a computer to manipulate digital images. This technology has many advantages such as elasticity, adaptability, data storage and communication. With the growth of various image resizing techniques, images can be stored efficiently. This technique has many rule sets that run synchronously in the image. 2D and 3D images can be processed multidimensionally.

1.2 Motivation for the work

A brain tumor is characterized as irregular development of cells inside the brain or central spinal canal. A few tumors can be cancerous hence they got to be identified and cured in time. The precise cause of brain tumors isn't clear and not one or the other is correct set of side effects characterized, hence, individuals may be enduring from it without realizing the peril. Essential brain tumors can be either dangerous (contain cancer cells) or generous (don't contain cancer cells).

Brain tumor happened when the cells were isolating and developing unusually. It is showing up to be a strong mass when it analyzed with demonstrative therapeutic imaging procedures. There are two sorts of brain tumor which is essential brain tumor and metastatic brain tumor. Essential brain tumor is the condition when the tumor is shaped within the brain and tended to remain there whereas the metastatic brain tumor is the tumor that's shaped somewhere else within the body and spread through the brain.

The indication having of brain tumor depends on the area, estimate and sort of the tumor. It happens when the tumor compressing the encompassing cells and gives out weight. Other than, it is additionally happening when the tumor squares the liquid that streams all through the brain. The common indications are having migraine, queasiness and heaving, and having issue in adjusting and strolling. Brain tumor can be identified by the symptomatic imaging modalities such as CT filter and MRI. Both of the modalities have points of interest in identifying depending on the area sort and the reason of examination required. In this paper, we lean toward to utilize the MRI pictures since it is simple to look at and gives out exact calcification and outside mass area.

The MRI is the foremost frequently utilized procedure for imaging brain tumors and the distinguishing proof of its region. The ordinary method for CT and MR picture classification and location of tumor cells remains to a great extent upheld for the human investigating separated from distinctive other strategies. MR pictures are basically utilized since there are non-destructive and non-ionizing. MR imaging offers high-definition pictures that are broadly utilized in finding brain tumors. MRI has different plans such as energy, T1-weighted, T2-weighted pictures. There are numerous picture preparing procedures such as pre-processing, division of pictures, picture changes, include extraction, and classifiers.

1.3 Problem Statement :

Our study is about bargains with mechanised brain tumor location and classification. Ordinarily the life structures of the brain is analyzed by MRI looks or CT checks. The point of the paper is tumor distinguishing proof in brain MR images. The main reason for the location of brain tumors is to supply aid to clinical conclusion. The point is to supply an algorithm that ensures the nearness of a tumor by combining a few strategies to supply a secure strategy of tumor discovery in MR brain images. The strategies utilized are sifting, disintegration, widening, edge and laying out of the tumor such as edge discovery.

The center of this venture is MR brain images tumor extraction and its representation in less complex shape such that it is reasonable by everybody. The objective of this work is to bring a few valuable data in less difficult frame in front of the clients, particularly for the therapeutic staff treating the quiet. The point of this work is to characterize an calculation that will result in extricated picture of the tumor from the MR brain picture.

The resultant picture will be able to supply data like measure, measurement and position of the tumor, and its boundary gives us with data related to the tumor that can demonstrate useful for different cases, which can provide a way better base for the staff to decide the curing method. At long last, we distinguish whether the given MR brain picture has tumor or not using Machine Learning Algorithms.

1.4 Scope

Our point is to create an mechanized framework for upgrade, division and classification of brain tumors. The framework can be utilized by neurosurgeons and healthcare masters. The framework joins picture handling, design examination, and computer vision strategies and is anticipated to make strides the affectability, specificity, and effectiveness of brain tumor screening. The essential objective of therapeutic imaging ventures is to extricate important and exact data from these pictures with the slightest blunder conceivable. The correct combination and parameterization of the stages empowers the improvement of aide instruments that can offer assistance on the early determination or the observing of the tumor distinguishing proof and areas.

1.5 Organization of the report

The report is divided into five chapters. Each chapter deals with the different aspects.

Chapter 1 of the report is the project introduction with its theme followed by the motivation of the work, problem statement and its scope.

Chapter 2 is almost all theories related to proposed extend counting specialized angle and assets are clarified. This area begins with all the Computer program prerequisites on which the proposed venture is built. At that point a writing overview is archived expressing most well known existing applications beneath space of current venture and their key highlights. Within the conclusion, current extend and its yield will be compared with the existing application and key highlights of current extend will be assessed.

Chapter 3 focuses on properly and clearly defining the title and goals of the project. Later, this chapter also contains the necessary objectives that must be met to complete this project. Functional requirements are well documented in this section as they require designing different diagrams that give a complete view of the project. Following this are the procedures and methods that tabulate the steps to be followed to achieve the objective. This section ends with a summary.

In Chapter 4, the actual dissection of project is done and each module is built piece by piece in order to complete the project. In design section, the application has been built in accordance with functional requirements. In implementation section, snips of important code is displayed with their explanation given below. In testing section, all functional requirements are tested and the result is analysed resulting in status of test condition. In the ending section, performance analysis is done on various factors.

Chapter 5 describes the completion of the overall project and the completion of each section included in the report. The completion status of each section is also specified, and it is all explained. This section ends with suggestions and scope for future work that will direct this project towards new technical opportunities. This project allows us to extend the same project to meet the customer's needs from time to time.

2.Background Theory

In this chapter, all theory related to proposed project including technical aspect and resources are explained. This section starts with all the Software requirements on which the proposed project is built. Then a literature survey is documented stating most popular existing applications under domain of current project and their key features. In the end, current project and its output will be compared with the existing application and key features of current project will be evaluated.

2.1 Background Theory :

This section gives complete knowledge and understanding of different technologies and softwares that were required in this project for its completion. Actually our project is based on Machine Learning algorithms. The background theory is listed below:

2.1.1 Software Configurations :

❖ Windows: Python 3.6.2 or above, PIP and NumPy 1.13.1

➢ **Python :**

Python is an interpreted, high-level, general purpose programming language created by Guido Van Rossum and first released in 1991, Python's design philosophy emphasizes code Readability with its notable use of significant Whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects. Python is dynamically typed and garbage collected. It supports multiple programming paradigms, including procedural, object-oriented, and functional programming.

- **PIP :**

It is the package management system used to install and manage software packages written in Python.

- **Numpy :**

NumPy is a general-purpose array-processing package. It provides a high performance multidimensional array object, and tools for working with these arrays. It is the fundamental package for scientific computing with Python. It contains various features including these important ones:

- A powerful N-dimensional array object
- Sophisticated (broadcasting) functions
- Tools for integrating C/C++ and Fortran code
- Useful linear algebra, Fourier transform, and random number capabilities

- **Pandas :**

Pandas is the most popular python library that is used for data analysis. It provides highly optimized performance with back-end source code is purely written in C or Python. We can analyze data in pandas with

1. Series
2. Data frames

- **Anaconda :**

Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing that aims to simplify package management and deployment. Package versions are managed by the package management system conda. The Anaconda distribution includes data-science packages suitable for Windows, Linux, and macOS. Anaconda distribution comes with 1,500 packages selected from PyPI as well as the conda package and virtual environment manager. It also includes a GUI, Anaconda Navigator, as a graphical alternative to the command-line interface (CLI).

- **Jupyter Notebook :**

Anaconda distribution comes with 1,500 packages selected from PyPI as well as the conda package and virtual environment manager. It also includes a GUI, Anaconda Navigator, as a graphical alternative to the command line interface (CLI). A Jupyter Notebook document is a JSON document, following a versioned schema, and containing an ordered list of input/output cells which can contain code, text mathematics, plots and rich media, usually ending with the ". ipynb" extension.

- **OpenCV :**

OpenCV (Open source computer vision) is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was later supported by willow garage then Itseez (which was later acquired by Intel). The library is cross platform and free for use under the open source BSD license. OpenCV supports some models from deep learning frameworks like TensorFlow, Torch, PyTorch (after converting to an ONNX model) and Caffe according to a defined list of supported layers. It promotes Open Vision Capsules. which is a portable format, compatible with all other formats.

- **Matplotlib** :

Matplotlib is an amazing visualization library in Python for 2D plots of arrays. Matplotlib is a multi-platform data visualization library built on NumPy arrays and designed to work with the broader SciPy stack. It was introduced by John Hunter in the year 2002. One of the greatest benefits of visualization is that it allows us visual access to huge amounts of data in easily digestible visuals. Matplotlib consists of several plots like line, bar, scatter, histogram etc. Installation : Windows, Linux and macOS distributions have matplotlib and most of its dependencies as wheel packages.

➢ **Sci-kit Learn** :

Scikit-learn is an open-source Python library that implements a range of machine learning, pre-processing, cross-validation, and visualization algorithms using a unified interface. Some of the important features of scikit-learn are :

- Simple and efficient tools for data mining and data analysis. It features various classification, regression and clustering algorithms including support vector machines, random forests, gradient boosting, k-means, etc.
- Accessible to everybody and reusable in various contexts.
- Built on the top of NumPy, SciPy, and matplotlib.
- Open source, commercially usable – BSD license.

2.1.2 Hardware Configurations :

- Processor: Intel core i5 or above.
- 64-bit, quad-core, 2.5 GHz minimum per core
- Ram: 4 GB or more
- Hard disk: 10 GB of available space or more.
- Display: Dual XGA (1024 x 768) or higher resolution monitors
- Operating system: Windows

2.2 Literature survey of the existing theories :

In medical diagnosis, the robustness and accuracy of predictive algorithms are very important. Because the results are very important for patient care. There are many common classification and clustering algorithms used for prediction. The purpose of clustering medical images is to simplify the representation of the images into meaningful images and facilitate their analysis. Several clustering and classification algorithms aim to improve the predictive accuracy of the diagnostic process in detecting anomalies.

Within the writing study we offer a brief outline of the diverse strategies that have been proposed for clustering over the period of 2002 to 2018.We have been in spite of the fact that 25 papers each of which encompasses a one of a kind approach towards division in a few parameter or the other. The rundowns of each of the papers are given underneath.

- **A. Sivaramakrishnan And Dr. M. Karnan "A Novel Based Approach for Extraction Of Brain Tumor In MRI Images Using Soft Computing Techniques," International Journal Of Advanced Research In Computer And Communication Engineering, Vol. 2, Issue 4, April 2013.**

A. Sivaramakrishnan et al. (2013) [1] projected an efficient and innovative discovery of the brain tumor vicinity from an image that turned into finished using the Fuzzy Capproach grouping algorithm and histogram equalization. The disintegration of images is achieved by the usage of principal factor evaluation is done to reduce the extent of the wavelet coefficient. The outcomes of the anticipated FCM clustering algorithm accurately.

- **Asra Aslam, Ekram Khan, M.M. Sufyan Beg, Improved Edge Detection Algorithm for Brain Tumor Segmentation, Procedia Computer Science, Volume 58,2015, Pp 430-437, ISSN 1877-0509.**

M. M. Sufyan et al. [2] has presented a detection using enhanced edge technique for brain-tumor segmentation that mainly relied on Sobel feature detection. Their presented work associates the binary thresholding operation with the Sobel approach and excavates diverse extents using a secure contour process. After the completion of that process, cancer cells are extracted from the obtained picture using intensity values.

- **B.Sathya and R.Manavalan, Image Segmentation by Clustering Methods: Performance Analysis, International Journal of Computer Applications (0975 – 8887) Volume 29– No.11, September 2011.**

Sathya et al. (2011) [3], provided a different clustering algorithm such as K-means, Improvised K-means, C-means, and improvised C-means algorithms. Their paper presented an experimental analysis for massive dat=asets consisting of unique photographs. They analyzed the discovered consequences using numerous parametric tests.

- **Devkota, B. & Alsadoon, Abeer & Prasad, P.W.C. & Singh, A.K. & Elchouemi, A. (2018). Image Segmentation for Early Stage Brain Tumor Detection using Mathematical Morphological Reconstruction. Procedia Computer Science. 125. 115-123. 10.1016/j.procs.2017.12.017.**

B. Devkota et al. [4] have proposed that a computer-aided detection (CAD) approach is used to spot abnormal tissues via Morphological operations. Amongst all different segmentation approaches existing, the morphological opening and closing operations are preferred since it takes less processing time with the utmost efficiency in withdrawing tumor areas with the least faults.

- **K. Sudharani, T. C. Sarma and K. Satya Rasad, "Intelligent Brain Tumor lesion classification and identification from MRI images using a K-NN technique," 2015 International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT), Kumaracoil, 2015, pp. 777-780. DOI: 10.1109/ICCICCT.2015.7475384**

K. Sudharani et al. [5] presented a K- nearest neighbor algorithm to the MR images to identify and confine the hysterically full-fledged part within the abnormal tissues. The proposed work is a sluggish methodology but produces exquisite effects. The accuracy relies upon the sample training phase.

- **Kaur, Jaskirat & Agrawal, Sunil & Renu, Vig. (2012). A Comparative Analysis of Thresholding and Edge Detection Segmentation Techniques. International Journal of Computer Applications.vol. 39.pp. 29-34. 10.5120/4898-7432.**

Jaskirat Kaur et al. (2012) [6] defined a few clustering procedures for the segmentation process and executed an assessment on distinctive styles for those techniques. Kaur represented a scheme to measure selected clustering techniques based on their steadiness in exceptional tenders. They also defined the diverse performance metric tests, such as sensitivity, specificity, and accuracy.

- **Li, Shutao, JT-Y. Kwok, IW-H. Tsang and Yaonan Wang. "Fusing images with different focuses using support vector machines." IEEE Transactions on neural networks 15, no. 6 (2004): 1555-1561.**

J. T. Kwok et al. [7] delivered wavelet-based photograph fusion to easily cognizance at the object with all focal lengths as several vision-related processing tasks can be carried out more effortlessly when wholly substances within the images are bright. In their work Kwok et al. investigated with different datasets, and results show that presented work is extra correct as it does not get suffering from evenness at different activity stages computations.

- **M. Kumar and K. K. Mehta, "A Texture based Tumor detection and automatic Segmentation using Seeded Region Growing Method," International Journal of Computer Technology and Applications, ISSN: 2229-6093, Vol. 2, Issue 4, PP. 855-859 August 2011.**

Kumar and Mehta [8] proposed the texture-based technique in this paper. They highlighted the effects of segmentation if the tumor tissue edges aren't shrill. The performance of the proposed technology may get unwilling results due to those edges. The texture evaluation and seeded region approach turned into executed inside the MATLAB environment.

- **Mahmoud, Dalia & Mohamed, Eltaher. (2012). Brain Tumor Detection Using Artificial Neural Networks. Journal of Science and Technology. 13. 31-39.**

Dalia Mahmoud et al. [9] presented a model using Artificial Neural Networks for tumor detection in brain images. They implemented a computerized recognition system for MR imaging the use of Artificial Neural Networks. That was observed that after the Elman community was used during the recognition system, the period time and the accuracy level were high, in comparison with other ANNs systems. This neural community has a sigmoid characteristic which elevated the extent of accuracy of the tumor segmentation.

- **Marroquin J.L., Vemuri B.C., Botello S., Calderon F. (2002) An Accurate and Efficient Bayesian Method for Automatic Segmentation of Brain MRI. In: Heyden A., Sparr G., Nielsen M., Johansen P. (eds) Computer Vision — ECCV 2002. ECCV 2002. Lecture Notes in Computer Science, vol 2353. Springer, Berlin, Heidelberg.**

L. Marroquin et al. [10] presented the automated 3d segmentation for brain MRI scans. Using a separate parametric model in preference to a single multiplicative magnificence will lessen the impact on the intensities of a grandeur. Brain atlas is hired to find nonrigid conversion to map the usual brain. This transformation is further used to segment the brain from nonbrain tissues, computing prior probabilities and finding automatic initialization and finally applying the MPM-MAP algorithm to find out optimal segmentation. Major findings from the study show that the MPM-MAP algorithm is comparatively robust than EM in terms of errors while estimating the posterior marginal. For optimal segmentation, the MPM-MAP algorithm involves only the solution of linear systems and is therefore computationally efficient.

- **Minz, Astina, and Chandrakant Mahobiya. "MR Image Classification Using Adaboost for Brain Tumor Type." 2017 IEEE 7th International Advance Computing Conference (IACC) (2017): 701-705.**

Astina minz et al. [11] implemented an operative automatic classification approach for brain image that projected the usage of the AdaBoost gadget mastering algorithm. The proposed system includes three main segments. Pre-processing has eradicated noises in the datasets and converted images into grayscale. Median filtering and thresholding segmentation are implemented in the pre-processed image.

- **Monica Subashini.M, Sarat Kumar Sahoo, "Brain MR Image Segmentation for TumorDetection using Artificial Neural Networks," International Journal of Engineering and Technology (IJET), Vol.5, No 2, Apr-May 2013.**

Monica Subashini and Sarat Kumar Sahoo [12] has suggested a technique for detecting the tumor commencing the brain MR images. They also worked on different techniques, which include pulse-coupled Neural Network and noise removal strategies for reinforcing the mind MRI images and backpropagation network for classifying the brain MRI images from tumor cells. They observed image enhancement and segmentation of the usage of their proposed technique, and the backpropagation network helps in the identification of a tumor in a brain MR image.

- **S. Li, J.T. Kwok, I.W Tsang, and Y. Wang, —Fusing Images with Different Focuses using Support Vector Machines, Proceedings of the IEEE transaction on Neural Networks, China, November 2007.**

Li et al. [13] report that edge detection, image segmentation, and matching are not easy to achieve in optical lenses that have long focal lengths. Previously, researchers have proposed many techniques for this mechanism, one of which is wavelet-based image fusion. The wavelet function can be improved by applying a discrete wavelet frame transform (DWFT) and a support vector machine (SVM). In this paper, the authors experimented with five sets of 256-level images. Experimental results show that this technique is efficient and more accurate as it does not get affected by consistency verification and activity level measurements. However, the paper is limited to only one task related to fusion, and dynamic ranges are not considered during the calculation.

- **H. Yu and J.L. Fan, —Three-level Image Segmentation Based on Maximum Fuzzy Partition Entropy of 2-D Histogram and Quantum Genetic Algorithm, Advanced Intelligent Computing Theories, and Applications. With Aspects of Artificial Intelligence. Lecture Notes in Computer Science, Berlin, Heidelberg 2008.**

Yu et al. [14] state that image segmentation is used for extracting meaningful objects from an image. They propose segmenting an image into three parts, including dark, grey and white. Z-function and s-function are used for the fuzzy division of the 2D histogram. Afterward, QGA is used for finding a combination of 12 membership parameters, which have a maximum value. This technique is used to enhance image segmentation and the significance of their work is that three-level image segmentation is used by following the maximum fuzzy partition of 2D Histograms. QGA is selected for the optimal combination of parameters with the fuzzy partition entropy. The proposed method of fuzzy partition entropy of 2D histogram generates better performance than one-dimensional 3-level thresh holding method. Somehow, a large number of possible combinations of 12 parameters in a multi-dimensional fuzzy partition are used, and it is practically not feasible to compute each possible value; therefore, QGA can be used to find the optimal combination.

- **P.S. Mukambika, K Uma Rani, "Segmentation and Classification of MRI Brain Tumor," International Research Journal of Engineering and Technology (IRJET), Vol.4, Issue 7, 2017, pp. 683 – 688, ISSN: 2395-0056**

Mukambika et al. [15] proposed methodology for the subsequent stage's classification of the tumor, whether it is present or not. Their proposed work represents the comparative study of strategies used for tumor identification from MR images, namely the Level set approach and discrete wavelength transforms (DWT) and K-method segmentation algorithms. After that phase, feature extraction is done followed SVM classification.

- **Pan, Yuehao & Huang, Weimin & Lin, Zhiping & Zhu, Wanzheng & Zhou, Jiayin & Wong, Jocelyn & Ding, Zhongxiang. (2015). Brain tumor grading based on Neural Networks and Convolutional Neural Networks. Conference proceedings: Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Conference. 2015. 699-702. 10.1109/EMBC.2015.7318458.**

Yuehao Pan et al., [16] has used brain MRI pix for getting useful statistics for classifying brain tumor. In their proposed method, they used Convolutional Neural Networks (CNN) algorithms for developing a brain tumor detection system. The performance of their CNN report is measured primarily based on sensitivity and specificity parameters, which have stepped forward when in comparison to the Artificial Neural Networks (ANN).

- **S. Pereira, A. Pinto, V. Alves, and C. A. Silva, "Brain Tumor Segmentation Using Convolutional Neural Networks in MRI Images," in IEEE Transactions on Medical Imaging, vol. 35, no. 5, pp. 1240-1251, May 2016.**

S. Pereira et al. [17] presented that magnetic resonance prevents physical segmentation time in the medical areas. So, an automatic and reliable segmentation technique for identifying abnormal tissues by using Convolutional Neural Network (CNN) had been proposed in the research work. The massive three-dimensional and underlying roughness amongst brain images makes the process of segmenting the image a severe issue, so a robust methodology such as CNN is used.

- **S. Roy And S. K. Bandyopadhyay, "Detection and Qualification Of Brain Tumor From MRI Of Brain And Symmetric Analysis," International Journal Of Information And Communication Technology Research, Volume 2 No.6, June 2012, Pp584-588**

Roy et al. (2012) [18] calculated the tumor affected area for proportioned analysis. They confirmed its software with numerous statistics groups with distinctive tumor sizes, intensities, and location. They showed that their algorithm could robotically hit upon and phase the brain tumor from the given photo. Image pre-processing consists of fleeting that pictures to the filtering technique to remove distractors found in given pictures. They first detect the tumor, segment it and then find out the area of tumor. One of the important aspects is that after performing the quantitative analysis, we can identify the status of an increase in the disease. They have suggested multi-step and modular approach to solve the complex MRI segmentation problem. Tumor detection is the first step in tumor segmentation. They have obtained good results in complex situations. The authors claim that MRI segmentation is one of the essential tasks in the medical area but boring and time-consuming if it is performed manually, so visually study of MRI is more interesting and faster.

- **Sankari Ali, and S. Vigneshwari. "Automatic tumor segmentation using convolutional neural networks." 2017 Third International Conference on Science Technology Engineering & Management (ICONSTEM) (2017): 268-272.**

A. Sankari and S. Vigneshwari [19] has proposed a Convolutional Neural Network (CNN) segmentation, which principally based on the brain tumor classification method. The proposed work used the non-linearity activation feature that's a leaky rectified linear unit (LReLU). They primarily focused on necessary capabilities, which include mean and entropy of the image and analyzed that the CNN algorithm is working higher for representing the complicated and minute capabilities of brain tumor tissues present in the MR Images.

- **T.U Paul and S.K. Bandyopadhyay, —Segmentation of Brain Tumor from Brain MRI Images Reintroducing K – Means with advanced Dual Localization +MethodTuhin, || International Journal of Engineering Research and Applications, Volume 3, Issue 1, June 2012, ISSN 2278-0882.**

T. T.U Paul and S.K. Bandyopadhyay [20] has presented the brain segmentation that has automated the use of the Dual Localization technique. In the initial phase, the skull masks are generated for the brain MR images. The tumor areas are improvised using the K-manner procedure. In the final step of their proposed work, they evaluated by its dimensions such as length and breadth.

- **Vaishali et al. (2015) Wavelet-based feature extraction for brain tumor diagnosis—a survey. Int J Res Appl Sci Eng Technol (IJRASET) 3(V), ISSN: 2321-9653**

Vaishali [21] proposed a method that includes step by step procedure starting with image pre-processing followed by extraction of useful objects and finally classification of tumor region. Pre-processing is completed to enhance the image using eliminating the noise via making use of Gaussian filters from the authentic ones. The next step is feature extraction, in which a magnified image is used to extract the feature using a symlet wavelet technique. The very last step is the classification of tumors by the use of a Support vector machine (SVM).

- **Varuna Shree, N., Kumar, T.N.R. Identification and classification of brain tumor MRI images with feature extraction using DWT and probabilistic neural network. Brain Inf. 5, 23–30 (2018) DOI:10.1007/s40708-017-00755**

Kumar and Varuna Shree [22] proposed work for the detection tumor region using discrete wavelength transforms (DWT). This work consists of three phases, namely an image enhancement using filtering technique, gray-level co-incidence matrix (GLCM) feature extraction of tumor in addition to DWT based tumor location developing segmentation. It is used to improve overall performance and reduce complexity. The denoised accompanied by the aid of morphological filtering operations which put off the noises that can be even shaped subsequent segmentation technique. The PNN classifier is to use for classifying the abnormality, which is trained by different datasets, and the accuracy is measured within the detection of tumor region of mind MR images.

- **Vinotha, K., 2014. “Brain Tumor Detection and Classification Using Histogram Equalization and Fuzzy Support Vector Machine Approach,” International Journal of Engineering and Computer Science ISSN23197242 3(5): 5823-5827.**

K. Vinotha et al. [23] proposed brain tumor detection and the usage of the Histogram Equalization (HE) and the Fuzzy Support Vector Machine (FSVM) classification techniques. The brain MR image is pre-processed with histogram equalization and segmented the apprehensive components from the photo primarily based on the MRF algorithm for segmentation technique. MRF approach expanded the tumor segmentation accuracy through which the overall performance of the proposed approach changed into advanced.

- **Sing, J.K. & Basu, D.K. & Nasipuri, Mita & Kundu, Megha. (2003). Improved k-means algorithm in the design of RBF neural networks. 2. 841 - 845 Vol.2. 10.1109/TENCON.2003.1273297.**

Sing et al. [24] propose a fuzzy adaptive RBI based neural network for MR brain image segmentation. The hidden layer neuron of FARBF-NN neurons has been fuzzified to reduce noise effect. Basu et al. assert that the medical image segmentation approach involves a combination of texture and boundary information. The authors maintain that geometric algebra can be used to obtain volumetric data representation using spheres, nonrigid registration of spheres and real-time object tracking. Major contribution of the proposed approach is that the use of the marching cube algorithm reduces the number of primitives to model volumetric data and uses a lesser number of primitives for the registration process, and thus makes the registration process faster. However, the study has employed images obtained from CT scans, which has its own limitations like blurred boundaries and similar grey levels between healthy and non-healthy tissues.

- **Shi, Z., He, L., Suzuki, K., Nakamura, T., & Itoh, H. (2009). Survey on Neural Networks Used for Medical Image Processing. International Journal of computational science, 3(1), 86–100.**

Shi et al. [25] employed neural networks for medical image processing, including the key features of medical image pre-processing, segmentation, and object detection and recognition. The study employed Hopfield and feedforward neural networks. The feedforward and Hopfield neural networks are simple to use and easy to implement. The added advantage of Hopfield neural networks is that it does not require pre-experimental knowledge. The time required to resolve image processing predicament is substantially reduced by using a trained neural network.

2.3 A Survey on Brain Tumor Detection Techniques Using MRI :

The brain tumor is an anomalous development of cells interior the cranium which causes harm to the other cells vital for working human brain. Brain tumor location could be a challenging assignment due to the complex structure of the human brain. MRI pictures produced from MRI scanners using strong attractive areas and radio waves to make pictures of the body which makes a difference for therapeutic conclusion. This paper gives an outline of the different strategies utilized to identify the tumor within the human brain utilizing MRI pictures.

2.3.1 Detection of Tumor in MRI Images Using Artificial Neural Networks :

Programmed abandons location in MR images is exceptionally critical in numerous demonstrative and helpful applications. This work has presented one programmed brain tumor location strategy to extend the precision and abdicate and diminish the determination time. The objective is classifying the tissues into two classes of ordinary and unusual. MR pictures that have been utilized here are MR pictures from ordinary and unusual brain tissues. This strategy employments from neural organize to do this classification. The reason of this extend is to classify the brain tissues to ordinary and anomalous classes consequently, which spares the radiologist time, increments exactness and abdicate of determination.

2.3.2 A Neural Network-based Method for Brain Abnormality Detection in MR Images Using Gabor Wavelets :

These days, programmed absconds discovery in MR images is exceptionally imperative in numerous symptomatic and restorative applications. This paper presents a Novel programmed brain tumor discovery strategy that employments T1, T2_weighted and PD, MR images to decide any variation from the norm in brain tissues. Here, it has been attempted to allow a clear portrayal from brain tissues utilizing Gabor wavelets, vitality, entropy, differentiate and a few other measurement highlights such as cruel, middle, change, relationship, values of greatest and least escalated. It is utilized from a include determination strategy to diminish the highlight space as well. this strategy employments from neural organize to do this classification. The reason of this venture is to classify the brain tissues to typical and irregular classes naturally, which spares the radiologist time, increments exactness and surrender of determination.

2.4 Conclusion

In this Chapter, all background knowledge for completion of this project are explained elaborately. Also, in each mentioned software and hardware requirements, the reason for its use is also expressed. Several languages, libraries and packages like Python, PIP, Numpy, Pandas, OpenCV, Sci-ket learning, Anaconda, Matplotlib etc. and its use in this project is explained. As we have done this project based on machine learning algorithm so each requirement is described briefly. Also we have listed some of the literature survey of the existing theories present based on this domain so that we can get more references to work on the idea of this project.

3. Aim and Objectives

This chapter focuses on defined title and Aim of the project correctly and clearly. Later this chapter also includes the required objectives that needed to be fulfilled in order to complete this project. Functional Requirements are well documented in this section since it is required to design different diagrams leading to complete view of the project. This is followed by method and methodologies that tabulates the procedure at will be followed in order to complete the objectives. This section then ends with a summary.

3.1 Title

Brain Tumor detection and classification using Machine Learning Algorithms

3.2 Aim

Efficient and accurate classification of brain MRI images as positive for tumors or negative for tumors at an early stage for timely and effective medical intervention.

3.3 Objectives

The objectives of the proposed Project are listed below:

1. Preparing the dataset for testing and training the algorithm by collecting the MRI images of the brain.
2. Preprocessing the data to put it in a format that can be easy to analyze by the computer and also normalize the pixel values of the images.
3. Select appropriate machine learning models that can be trained to predict the outcome with the highest accuracy.
4. To evaluate the selected machine learning models on the testing data using the accuracy score.
5. To predict if there's a possibility of a brain tumour by feeding the MRI image of a brain into the trained machine learning model.

6. To display the predicted class of the image as Tumor or No-Tumor along with the image fed into the machine learning model.

3.4 Functional Requirements

Some of the common functional requirements for this project are mentioned below:

1. Accurate detection: The system must be able to accurately detect the presence of brain tumors in medical images with a high level of sensitivity and specificity.
2. Efficient processing: The system must be able to process medical images quickly and efficiently to provide timely diagnoses and treatment recommendations.
3. Robustness: The system should be able to handle variations in image quality and other factors that may affect the accuracy of the analysis.
4. Interpretable results: The system should be able to provide clear and interpretable results to medical professionals, including information about the location, size, and type of tumor detected.
5. Scalability: The system should be able to handle large volumes of medical images and be easily scalable as needed.
6. Integration: The system should be able to integrate with existing medical imaging software and workflows to facilitate seamless use in clinical settings.
7. Continual learning: The system should be able to learn from new data and improve over time, incorporating new techniques and algorithms as they become available.

Overall, the functional requirements for a brain tumor detection system using machine learning algorithms must prioritize accuracy, efficiency, robustness, and integration with existing medical workflows while ensuring patient privacy and security.

3.5 Non-Functional Requirements

All the non-functional constraints of this project are mentioned below :

1. Security: Patient data should be kept confidential and secure to prevent unauthorized access and data breaches.
2. Usability: The system should be easy to use, with a simple and intuitive interface that is easy to navigate.
3. Maintainability: The system should be easy to maintain, with minimal downtime and easy updates.
4. Interoperability: The system should be able to work with other systems and software, ensuring compatibility with existing infrastructure.
5. Reliability: The system should be reliable, which means that it should be able to operate consistently and predictably under varying conditions.
6. Ethical considerations: The system should adhere to ethical guidelines for medical diagnosis and treatment, and should not discriminate or harm patients in any way.

3.6 Methods and Methodology/Approach to attain each objective

Table 1

Objective No.	Statement of the Objective	Method/ Methodology	Resources Utilised
1	Preparing the dataset for testing and training the algorithm by collecting the MRI images of the brain.	1.1 At first to create a machine learning model for brain tumor detection is to collect a large dataset of MRI images. 1.2 These images can be obtained from medical	Various online databases and commercial websites.

		institutions, research centers, or publicly available sources. 1.3 The dataset should contain a balanced number of images with and without tumors.	
2	Preprocessing the data to put it in a format that can be easy to analyze by the computer and also normalize the pixel values of the images.	2.1 The MRI images need to be preprocessed to prepare them for analysis by the machine learning model. 2.2 This includes resizing the images to a uniform size, normalizing the pixel values to a standard range, and converting the images to a format that can be easily analyzed by the computer, such as Python's OpenCV	Various online databases and commercial websites.
3	Select appropriate machine learning models that can be trained to predict the outcome with the highest accuracy.	3.1 Appropriate machine learning models need to be selected for the task of predicting the presence of a brain tumor. 3.2 The models can range from simple logistic regression	Logical Regression and Support Vector Machine along with the help of mentor

		models to complex deep learning models like convolutional neural networks (CNNs). 3.3 The choice of the model depends on the size and complexity of the dataset, as well as the desired level of accuracy.	
4	To evaluate the selected machine learning models on the testing data using the accuracy score.	4.1 Once the models have been selected, they need to be trained on the preprocessed dataset and evaluated on a separate testing dataset to determine their accuracy. 4.2 A common metric used to evaluate the performance of the model is the accuracy score, which measures the percentage of correctly classified images.	Jupyter Notebook, Python language and various libraries along with the help of mentor
5	To predict if there's a possibility of a brain tumour by feeding the	5.1 After the model has been trained and evaluated, it can be used to predict the presence of	Jupyter Notebook, Python language and various libraries along with the help of mentor

	MRI image of a brain into the trained machine learning model.	a brain tumor in a new MRI image. 5.2 This is done by feeding the preprocessed image into the trained model and generating a prediction.	
6	To display the predicted class of the image as Tumor or No-Tumor along with the image fed into the machine learning model.	6.1 Finally, the predicted class of the image (Tumor or No-Tumor) is displayed along with the image fed into the machine learning model. 6.2 This provides a visual representation of the prediction and helps clinicians to interpret the results.	Jupyter Notebook along with the help of mentor

3.7 Conclusion

This particular chapter focused on defined title and Aim of the project correctly. Later this chapter included required objectives that were required to be fulfilled to complete this project. Functional Requirements is documented successfully in this section followed by method and methodologies which is successfully tabulated in order to know the steps used in completing the objectives including resources used.

4 Discussion and Results

In this chapter, the actual dissection of project is done and each module is built piece by piece in order to complete the project. In design section, the application has been built in accordance with functional requirements. In implementation section, snips of important code is displayed with their explanation given below. In testing section, all functional requirements are tested and the result is analysed resulting in status of test condition. In the ending section, performance analysis is done on various factors..

4.1 Discussion:

We have trained both the SVM and the logistic regression models in the provided code to classify brain tumors. The same preprocessing techniques were used for both models' training on the same dataset. The performance of these two models will now be compared using a variety of evaluation criteria, including accuracy, F1 score, and F2 score. To better appreciate the advantages and disadvantages of these theories, we will also examine their confusion matrices.

- Interpretability: The link between the input features and the target variable can be understood using the interpretable coefficients that can be produced using logistic regression. On the other hand, SVM does not have a clear interpretation.
- Interpretability: Logistic regression can provide interpretable coefficients that can be used to understand the relationship between the input features and the target variable. SVM, on the other hand, does not have such a straightforward interpretation.
- Training time: SVM typically requires more training time than logistic regression, especially when working with large datasets. This is due to the fact that SVM

requires the solution of a computationally expensive quadratic optimization problem.

- Kernel selection: SVM highly depends on the choice of kernel function, which can have a big impact on how well it performs. In contrast, logistic regression does not need a kernel function, which makes it, in some situations, an easier model to utilise.
- Robustness to noise:SVM has the potential to be more noise-resistant than logistic regression, particularly when utilising a nonlinear kernel. However, logistic regression, particularly when applying regularisation, can be more resistant to outliers in the data.

4.2 Presentation of results :

Here we are comparing two algorithms for brain tumor detection using ML which are SVM and Logistic regression.

The results which we obtained are:

1) SVM:

    1.1) The confusion matrix for SVM:

```
In [9]: from sklearn.metrics import confusion_matrix

        # Make predictions on test set
        y_pred = sv.predict(xtest)

        # Create confusion matrix
        cm = confusion_matrix(ytest, y_pred)

        # Print confusion matrix
        print(cm)

        [[ 75   6]
         [  3 161]]
```

Figure 1

The code snippet in Figure 1 is using the scikit-learn library (sklearn) to calculate and print a confusion matrix. This is how it's working :

- from **"sklearn.metrics import confusion_matrix"** imports the **confusion_matrix** function from the **metrics** module in the scikit-learn library. The **confusion_matrix** function is used to compute a confusion matrix based on predicted and true labels.
- **"y_pred"** is using a model called **sv** on the test set **(xtest)**. It assumes that the model **sv** has already been trained on some training data and is ready to make predictions.
- **cm = confusion_matrix (ytest, y_pred)** calculates the confusion matrix by comparing the true labels (**ytest**) with the predicted labels (**y_pred**). The confusion matrix is a 2D matrix that summarizes the counts made by a classification model.
- **print(cm)** prints the confusion matrix . The confusion matrix will have dimensions equal to the number of classes in the classification problem. Each element in the matrix represents the count of instances that were predicted as belonging to a particular class (rows) while actually belonging to another class (columns).

1.2) The F1 and F2 for SVM:

```
In [11]: from sklearn.metrics import classification_report

         y_pred = sv.predict(xtest)

         print(classification_report(ytest, y_pred, target_names=['No Tumor', 'Positive Tumor'], digits=3))
```

```
                precision    recall  f1-score   support

      No Tumor      0.962     0.926     0.943        81
Positive Tumor      0.964     0.982     0.973       164

      accuracy                          0.963       245
     macro avg      0.963     0.954     0.958       245
  weighted avg      0.963     0.963     0.963       245
```

Figure 2

The code snippet in Figure 2 is using the scikit-learn library in Python to evaluate the performance of a classification model using the **classification_report** function. It provides an evaluation of the model's performance on the test set, showing precision, recall, F1-score, and support for each class, as well as accuracy and average metrics.

1.3) The accuracy for SVM

```
In [14]: from sklearn.metrics import accuracy_score

         y_pred = sv.predict(xtest)
         accuracy = accuracy_score(ytest, y_pred)
         print("Accuracy:", accuracy)

         Accuracy: 0.963265306122449

In [ ]:
```

Figure 3

In the code snippet of Figure 3, the **accuracy_score** function from the **sklearn.metrics** module is imported. This function is commonly used in machine learning to evaluate the performance of classification models. In our case, the accuracy score is **0.963265306122449**, which indicates that the classifier's predictions match the true labels for approximately **96.33%** of the test samples.

2) Logistic Regression(LR):

2.1) The confusion matrix for LR:

```
In [71]: from sklearn.metrics import confusion_matrix

         # Predict on test data
         y_pred = lg.predict(xtest)

         # Calculate confusion matrix
         cm = confusion_matrix(ytest, y_pred)

         # Print confusion matrix
         print("Confusion matrix:")
         print(cm)

         Confusion matrix:
         [[ 73   8]
          [  2 162]]
```

Figure 4

The code snippet in figure 4 demonstrates the calculation and printing of a confusion matrix using the **sklearn.metrics.confusion_matrix** function from the **scikit-learn** library.

- ➔ By importing the **confusion_matrix** function from the **sklearn.metrics** module, this function is used to compute the confusion matrix.
- ➔ The code have trained a **logistic regression** model (**lg**) on some training data and are using it to predict the labels for the test data **(xtest**).
- ➔ The **confusion_matrix** function is called with the true labels (**ytest**) and the predicted labels **(y_pred)**. It compares these two sets of labels and computes a confusion matrix based on the differences between them.
- ➔ The resulting **confusion matrix (cm)** is then printed as a table, where the rows represent the actual classes (true labels) and the columns represent the

predicted classes. The values in the matrix indicate the count or frequency of data points that fall into each combination of true and predicted classes.

By analyzing the confusion matrix, we can evaluate the performance of our classification model. It allows us to calculate various metrics such as accuracy, precision, recall, and F1-score, which provide insights into the model's ability to correctly classify different classes.

2.2) The F1 and F2 for LR:

```
In [72]: from sklearn.metrics import f1_score, fbeta_score

         # Predict on test data
         y_pred = lg.predict(xtest)

         # Calculate F1 score
         f1 = f1_score(ytest, y_pred)

         # Calculate F2 score
         f2 = fbeta_score(ytest, y_pred, beta=2)

         # Print F1 and F2 scores
         print("F1 score: {:.2f}".format(f1))
         print("F2 score: {:.2f}".format(f2))

         F1 score: 0.97
         F2 score: 0.98
```

Figure 5

The given code in Figure 5 calculates the F1 score and F2 score using the **f1_score()** and **fbeta_score()** functions from the **sklearn.metrics** module in scikit-learn. These scores are used to evaluate the performance of a binary classification model.

The printed output shows the calculated F1 score and F2 score, rounded to two decimal places. The F1 score is 0.97, indicating a high level of accuracy in the model's predictions.

The F2 score is 0.98, which suggests that the model performs even better when it comes to recall, as the F2 score gives more weight to recall compared to the F1 score

2.3) The accuracy for LR:

```
In [73]: from sklearn.metrics import accuracy_score

         # Predict on test data
         y_pred = lg.predict(xtest)

         # Calculate accuracy
         accuracy = accuracy_score(ytest, y_pred)

         # Print accuracy
         print("Accuracy: {:.2f}".format(accuracy))

         Accuracy: 0.96
```

Figure 6

It was found that SVM outperformed logistic regression based on the implementation and assessment of the algorithms on the provided brain tumor dataset.

Compared to logistic regression, which had an accuracy score of 0.96, the SVM method was able to reach a superior score of 0.963. This shows that SVM was more accurate at classifying the images of brain tumors than logistic regression.

SVM also had higher F1 and F2 scores than logistic regression, demonstrating that it was more accurate at both precision and recall. In comparison to logistic regression, the confusion matrix for SVM revealed fewer samples that were incorrectly classified.

Overall, our findings imply that SVM outperforms logistic regression in this brain tumor classification job. It is crucial to remember that the selection of algorithms may change depending on the precise dataset and issue at hand.

Here are some suggestions for further enhancing the functionality of the tumor classification model based on the findings and analysis:

1) Feature engineering is the process of identifying and removing the most crucial features from a dataset. By removing unnecessary or redundant features, cutting down on the number of features, or converting the data into a more appropriate format, it can be used to increase the model's accuracy. To find the most crucial features for classification in this situation, we can use a variety of feature selection techniques like principal component analysis (PCA), recursive feature elimination (RFE), or feature importance ranking.

2) Hyperparameter tuning: Hyperparameters are model parameters that are predetermined and are not learned during training. In SVM, these include the regularisation strength, kernel type, gamma value, and C value; in logistic regression, these are the regularisation strength and solver type. The performance of the model can be significantly enhanced by tuning these hyperparameters. To find the best hyperparameters for the model, we can employ methods like grid search, random search, or Bayesian optimization.

3) Model ensemble: To enhance overall performance, multiple models are combined in a model ensemble process. We can attempt to create an ensemble model in this situation by combining SVM and logistic regression models. The weighted average of the predictions from the two models can be used for this, or a meta-learner like a decision tree or a neural network can be used to learn how to combine the predictions from the base models.

4) Expand the dataset: As with any machine learning model, expanding the dataset can aid in enhancing the model's accuracy. To make the dataset larger in this instance, we can attempt to gather more information about tumor images. Additionally, we can

attempt to improve the current dataset by transforming the images by flipping, rotating, or scaling them.

We have additionally compared Random forest Algorithm which is significantly better than SVM and Logistic regression.

5. Conclusions and Suggestions for Future Work

In this chapter, conclusion has been given for entire project along with conclusion to each section present in the report. All are explained with status of completion of each section mentioned clearly. This section ends with Suggestion and scope of future work which direct this project towards new openings of technology where the same project can be extended in order to meet the requirement of customers time to time.

5.1 Conclusions

Brain tumor detection is a crucial task in the field of medical imaging, as early detection of brain tumors can lead to a better prognosis and increased chances of successful treatment. Machine learning techniques have been widely used for brain tumor detection, as they can automate the process of analysing and interpreting medical images.

In this project, we have learned about brain tumor detection using machine learning techniques in Python. We have used a dataset of MRI images of brain tumors and performed data analysis, data visualisation, and data preprocessing techniques such as splitting the data into training and testing datasets and feature scaling. We have trained two models, SVM and Logistic Regression, and compared their performances using evaluation metrics such as accuracy and F1-score. Finally, we have made predictions on the test dataset and examined the results.

The SVM model showed better performance than the Logistic Regression model, with a higher accuracy and F1-score. Therefore, we can conclude that the SVM model is an ideal model for this particular dataset. However, this project can be further improved by using more advanced machine learning algorithms and by incorporating more features from the MRI images to improve the accuracy of the model.

5.2 Suggestions for future work :

As for future work,there are several avenues in brain tumor detection using machine learning. Some potential areas of improvement for this project include:

- Increasing the size of the dataset: The current dataset used in this project contained a limited number of MRI images. Expanding the dataset can help to improve the accuracy and robustness of the machine learning models.
- Incorporating more advanced machine learning algorithms: While the SVM model performed well in this project, there are more advanced machine learning algorithms that could potentially improve the accuracy of the model. For example, deep learning techniques like convolutional neural networks (CNNs) have been shown to be effective in medical image analysis tasks.
- Deep learning architectures: Investigate and develop novel deep learning architectures specifically tailored for brain tumor detection and classification. This could involve combining convolutional neural networks (CNNs) with recurrent neural networks (RNNs) or attention mechanisms to effectively capture spatial and temporal information from medical images.
- Extracting more features from the MRI images: In this project, we extracted a limited number of features from the MRI images. However, there may be other features that can be extracted from the images that could improve the accuracy of the model. For example, texture analysis techniques can be used to extract texture features from the MRI images.
- Integration of advanced imaging techniques: Explore the integration of advanced imaging techniques, such as functional magnetic resonance imaging (fMRI), diffusion tensor imaging (DTI), or positron emission tomography (PET), to provide additional information for more accurate tumor detection and classification.

- Multimodal data fusion: Develop methods to integrate and fuse information from multiple imaging modalities (e.g., MRI, CT, PET) and other complementary data sources, such as genetic or clinical data. This fusion can potentially improve the accuracy and reliability of tumor detection and classification.
- Transfer learning and domain adaptation: Explore transfer learning techniques that allow the model to leverage pre-trained models from other medical imaging tasks or datasets. Additionally, investigate methods for domain adaptation to address the challenge of limited labeled data in the context of brain tumor detection and classification.
- Validation on diverse and large-scale datasets: Validate the proposed methods on diverse and large-scale datasets to ensure their generalizability and robustness across different populations, imaging protocols, and scanner manufacturers. Collaborating with multiple institutions and data sharing initiatives can facilitate the availability of such datasets
- Real-time and interactive systems: Design and develop real-time and interactive systems that enable clinicians to interact with the model during the tumor detection and classification process. This could involve providing immediate feedback and suggestions to aid in decision-making and enhance the workflow in a clinical setting.
- Incorporating clinical data: Clinical data such as patient age, gender, and medical history can also be incorporated into the machine learning model to improve its accuracy.
- Clinical trials and validation studies: Conduct rigorous clinical trials and validation studies to evaluate the performance and impact of the developed methods in real-world clinical settings. This would involve collaboration with medical

professionals and the integration of the proposed methods into the existing clinical workflow.

- Developing a web-based tool for brain tumor detection: A web-based tool that allows medical professionals to upload MRI images and obtain predictions on the presence of brain tumors can be developed. This tool can be integrated into existing medical imaging software to streamline the process of brain tumor detection.
- Ethical considerations and deployment: Address the ethical implications associated with the deployment of automated brain tumor detection and classification systems. Ensure that the technology is used responsibly, respects patient privacy, and is aligned with regulatory guidelines and standards.

Overall, there is a lot of potential for future work in brain tumor detection using machine learning. Improving the accuracy of the models can lead to better prognosis and treatment outcomes for patients with brain tumors.

6. Project Costing

This chapter deals with costing of this project which gives an overall estimation of expenses that was required to complete this project. This Covers expenses of Human Resource Cost and a grand total of entire software and hardware cost in the development.

6.1 Project Cost Estimation

The cost of project is summarised in a tabular form displayed below:

Table 2 Cost estimation table

Serial Number	Resources and Work	Cost(Rs)
1	Laptop for development (3*60,000 Rs)	1,80,000/-
2	Human Resources (5 Hours * 5 days * 12 weeks * 5 people * 400 Rs = 600000 Rs)	6,00,000/-
	TOTAL	7,80,000/-

6.2 Conclusion

Since this project didn't have any physical model, hence no expenses were made for physical model. However, effort on making the software via parallel learning of new technology raised the Human Resource cost which can be seen in Table 2.

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